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JOHN ALEXANDER McGEOCH

It is with profound sorrow that the *Psychological Bulletin* informs its readers of the death of Professor John Alexander McGeoch on March 3, 1942, after a brief illness.

Dr. McGeoch was completing his first term as Editor of the *Psychological Bulletin* and had been recently re-elected for a six-year term. He was born at Argyle, New York, on October 9, 1897. He received the bachelor's degree from Westminster College in 1918, the master's degree from Colorado College in 1919, and the doctor's degree from the University of Chicago in 1926. Dr. McGeoch served on the Council of the American Psychological Association from 1936 to 1939; and he was a coöperating editor on the *Psychological Bulletin* from 1931 until he became Editor. At the time of his death he was professor of psychology and head of the psychology department at the State University of Iowa. In his passing, experimental psychology loses a brilliant investigator of the learning process, and his wide circle of friends lose a genial comrade.

CENTRAL NERVOUS MECHANISMS INVOLVED IN THE REPRODUCTIVE BEHAVIOR OF VERTEBRATES[1]

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INTRODUCTION

Among the many avenues of approach to an understanding of human behavior several diverse lines of attack have proven fruitful. Two profitable methods of investigation have been the attempt to correlate man's behavior with the activity of his central nervous system, and efforts to gain insight into human reactions by explaining analogous responses in more easily studied lower animals. A combination of these two methods, involving an evolutionary approach to the problem of behavior and the nervous system, has achieved definite contributions and offers promise of rapid advancement toward a scientific interpretation of behavior.

As the physical structure of the Hominidae has evolved from that of more primitive vertebrates, certain phases of man's behavior have developed as an elaboration of simpler reaction patterns displayed by ancestral forms. Correlation between changes in structure and in function is especially striking in the case of the central nervous system. Progressive increase in the mass and degree of differentiation of the vertebrate forebrain has been paralleled by simultaneous modification of relationships between organism and environment. Increase in the modifiability of reaction patterns and decrease in the proportion of the behavior repertoire controlled by innate organization have occurred in conjunction with evolutionary changes in the telencephalon.

Although the progenitors of modern vertebrates are not available for experimental study, the relationships between behavior and evolutionary changes in the brain are subject to investigation. The evolution of certain types of behavior may be revealed by a study of one response pattern elicited in a number of different species selected from different levels on the phylogenetic scale. By investigating a form of behavior that persists throughout all classes and by determining the function of the brain in the mediation of

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such behavior, it is possible to gain at least a partial understanding of the relationships between evolutionary changes in the brain and concomitant alterations in behavior.

The present review constitutes an attempt to assemble evidence dealing with the function of the central nervous system in the reproductive behavior of vertebrates. Studies dealing with each class of vertebrates are presented together, although for many classes little or no evidence is available. Reproductive behavior includes activities involved in courtship, mating, and care of the young.

Fish

Among the cichlid fishes visual cues are of primary importance in reproductive activity. The blind male Jewel Fish (*Hemichromis bimaculatus*) can fertilize the eggs, but his behavior is totally lacking in coördination (**72**). According to Breder (**22**), mating behavior in all male cichlids involves visual recognition of the gravid female on the basis of characteristic movements of her dorsal and anal fins. Male Swordtails (*Xiphophorus helleri*) appear to recognize other males visually by the presence of the sword and gonopodium; and male Guppies (*Lebistes reticulatus*) discriminate visually the sex of other members of their own species (**67**). Male Rainbow Darters (*Etheostoma coeruleum*) differentiate between other males and females on the basis of visual cues (**76**). Gravid female Jewel Fish discriminate between males and females in adjacent aquaria (**72**).

Many fishes exhibit elaborate courtship and spawning behavior involving exact integration and synchronization of the responses of the sexual partners (**72**). In some species of cichlid fishes the forebrain is essential to the spatial and temporal organization of reproductive behavior.

Mating behavior in the Jewel Fish includes cleaning of a nest site, laying and fertilizing the eggs, guarding and fanning the eggs, removal of the newly hatched young to a previously prepared depression in the sand, and attracting the young by specific fin movements. In these activities both parents coöperate.

Unilateral destruction of the forebrain (corpus striatum) in this species does not prevent normal reproduction, but bilateral forebrain ablation abolishes courtship and mating (**70**). Small bilateral lesions to the forebrain do not interfere with normal courtship and spawning; but a female Jewel Fish suffering such brain injury may

not permit the male to assist her in care of the eggs and young. The normal mate of the operated female is often attacked if he approaches eggs or newly hatched brood (**68**). Normal brooding females ordinarily permit the male mate to assist in the care of the brood, but attack any other adult that approaches the eggs or young.

Extensive injury to both hemispheres of the forebrain disorganizes the mating and brooding responses of the Jewel Fish and may eliminate one or more of the behavioral elements in the serial pattern (**68**). There is no indication of localization of function within the corpus striatum. The number of elements eliminated is a function of the amount of forebrain removed, and the same defect can be produced by restricted destruction in different parts of the corpus striatum. Postoperative disruption of reproductive behavior is permanent, appearing in 12 to 28 spawnings over a period of 12 to 19 months.

Hormones may activate patterns of response in the Jewel Fish, but the forebrain is essential to the integration of discrete reactions into a biologically effective whole (**68**). Sensitization of the neural mechanisms involved occurs as a result of the first spawning. After but not before the initial spawning, brooding behavior can be induced in the female Jewel Fish by the administration of corpus luteum, progesterone, prolactin, anterior pituitary extract, fresh fish pituitary, thyroxin, or phenol (**73**).

The African Mouthbreeder fish (*Tilapia macrocephala*) exhibits a complex pattern of courtship and mating followed by two weeks of buccal brooding of the eggs by the male. Injury to the corpus striatum results in asynchronization of the parents' reproductive behavior (**66**). Control lesions in the cerebellum reduce plasticity of movement without affecting egg laying, fertilization, or buccal brooding.

In the courtship pattern of the Mexican Swordtail fish (*Xiphophorus helleri*) the male assumes all initiative. The female plays a completely passive role, and all of the male's behavior is oriented toward her. The courtship and spawning behavior of this viviparous species survives total forebrain ablation (**70**).

Amphibia

Evidence as to the neural basis of mating in the frog is contradictory. Tarchanoff (**6**) held that the sexual clasp of the male frog depends upon sensations arising from the distended sperm blad-

der. This view was thrown in question by reports of normal clasping in males castrated in breeding season (**42**, **83**). Clasping is eliminated, however, if castration occurs before the onset of the mating season. These data suggest the existence of an endocrine factor sensitizing the neural mechanisms responsible for amplexus.

Schrader (**85**) described a midbrain center which he regarded as essential to the maintenance of amplexus. Males deprived of the midbrain clasped females placed in their grasp but released quickly. Persistence of the males' clasp was regarded by Schrader as dependent upon tactile sensations mediated by the midbrain. Dissection of the midbrain caudal to the plexus of the cerebellum raised the excitability of the "clasp center," and males sustaining such injury clasped any object encountered.

Edinger (**42**) reported heightened clasp reflexes following transection of the medulla posterior to the cerebellum, and maintenance of amplexus despite decapitation. Tarchanoff (**6**) located the mechanisms essential to amplexus in the optic lobes. He found that electrical stimulation of this area induced clasping, and destruction of the superior colliculi eliminated the response. Similar results with the male toad led Baglioni (**5**) to the conclusion that the optic lobes contain excitatory centers mediating the sexual clasp. Directly contradictory conclusions were advanced by Tarchanoff (**6**) and Albertoni (**1**), whose independent investigations led them to believe that centers in the superior colliculi exert an inhibitory effect, causing relaxation of amplexus.

In *Rana pipiens* the sensory basis for pursuit and clasping of the female is apparently visual and tactile. Peripherally blind males of this species do not show the normal response of crossing the tank to clasp another frog, but will display amplexus if tactile stimulation occurs (**69**). At the same time the eyeless *pipiens* is quite inactive, displaying total loss or marked reduction of feeding behavior. Vision is apparently the dominant sense modality. The South African Clawed Toad (*Xenopus laevis*) possesses relatively small eyes and is seemingly less dependent upon visual cues in mating. Peripherally blind *Xenopus* clasp the female vigorously, but execute a high percentage of abnormal clasps, seizing the female by the forelimbs or hindlimbs instead of in the lumbar region. In such cases the clasp is usually corrected rapidly, and mating proceeds normally (**18**).

Noble and Aronson (**69**) found that pursuit and clasping of a female are not affected by removal of the forebrain of the male

frog (*Rana pipiens*) if the preoptic area is spared. Destruction of the preoptic area without injury to the remainder of the forebrain does not interfere with this behavior. Ablation of the entire forebrain including the preoptic area ordinarily eliminates pursuit of the female. However, a male deprived of all forebrain will follow and clasp the female if she swims by and comes in contact with any part of his body.

Apparently the normal male's tendency to cross the tank and approach another frog depends jointly upon vision and functions of the forebrain. Orientation of this character can be mediated centrally by the intact forebrain, by the preoptic area (in the absence of other portions), or by the remainder of the forebrain (in the absence of the preoptic area). With the occurrence of tactile stimulation, however, mating is independent of visual cues and of forebrain function. This conclusion receives support from the observation that the forebrainless male will clasp the female if placed upon her back (**6**). In addition, such a male maintains amplexus and executes all elements of the normal masculine pattern until the female has oviposited (**69**).

The frog's reduced responsiveness to many types of stimuli following destruction of the forebrain is reflected in the observations of several authors. Blankenagel (**20**) reported elimination of the "power of attention" and of "spontaneous movement" in decerebrate frogs. According to Burnett (**30**), the decerebrate frog is "incapable of forming even the simplest associations."

The experiments of Noble and Aronson (**69**) indicate that in the case of *Rana pipiens* the male's release of the female after oviposition depends upon the function of the preoptic area of the forebrain. Whereas normal males release the female within a minute after the eggs have been extruded, frogs suffering destruction of the preoptic region maintain a sexual clasp with the spent female for several hours after oviposition. Lesions to other parts of the forebrain do not affect the release response.

Reptiles

Investigations of brain function in the reproductive behavior of reptiles are limited. Information on this topic would be of especial value to a phylogenetic interpretation of behavior because the cerebral cortex makes its first appearance in the reptilian brain.

The sensory basis of mating reactions in lizards is not clearly defined, but vision is undoubtedly very important. Diebschlag

(**39**) reported nearly total inactivity in blind males. Noble and Bradley (**71**) regarded vision as the most important sense involved in the courtship of lizards. If a female *Sceloporus undulatus* is painted to look like a male, she is treated as a male by other individuals (**65**).

Unilateral decerebration has no effect upon the courtship and mating behavior of male Emerald Lizards (*Lacerta viridis*), according to Diebschlag (**39**). Males suffering loss of both cerebral hemispheres exhibit no reproductive behavior. Drastic reduction in all spontaneous activity accompanies loss of courtship and mating in the decerebrate reptiles.

Birds

Peripherally blinded male pigeons court the female, but fail in their copulatory attempts because of poor orientation (**84**). The role of visual stimuli in the female pigeon's ovulatory cycle is revealed in the findings of Matthews (**61**), who reported failure of ovulation in isolated birds. Females allowed sight of another pigeon or given mirrors in their own cages continued to lay eggs. Opportunity for auditory and olfactory stimulation derived from other pigeons was not followed by ovulation if visual stimuli were excluded.

According to Schrader (**85**), unilateral decerebration has no effect upon reproductive behavior in pigeons. The completely decerebrate female pigeon makes no response to the courtship of the male, and, although she lays eggs, will not brood them. The forebrainless male pigeon exhibits courtship and "shows plainly that it is in heat,—but its endeavours have no object." In a more recent study Rogers (**79**) found that decorticate pigeons are capable of mating, but loss of cortex and hyperstriatum eliminates reproductive behavior. Rogers suggested that the hyperstriatum "ties together" the discrete elements making up the mating pattern (cooing, fighting, regurgitation, preening, and copulation).

Mammals

Rabbit

Peripherally blind male rabbits mate with the estrous doe (**25, 84**). Anosmic males achieve coition without apparent difficulty (**25, 89**).

Bucks suffering abdominal sympathectomy mate with the female, but do not display orgasm or the final vocalization, and the

male's tendency to fall off of the female after ejaculation is absent from the copulatory pattern (3). Erection and ejaculation in the male rabbit occur in response to electrical stimulation of the sacral cord (40). Injury to various regions in the cerebral cortex (90, 91) or complete decortication (25) does not abolish mating in the male. Combined destruction of the cortex and the olfactory bulbs eliminates copulatory behavior (25). These findings suggested to Brooks the conclusion that several factors contribute to sexual arousal and mating. If a considerable portion of the neocortex is intact, the male rabbit is not dependent upon olfaction or vision. In the absence of neopallium the olfactory apparatus is essential to the initiation of mating behavior. Transection of the infundibulum does not prevent mating in the male (28).

Cauterization of the nasal mucosa is followed by reduction of sexual appetite and decrease in testicular volume in the male rabbit, according to Cahane and Cahane (31). After similar treatment the female's breeding behavior and gestation are normal.

In the female rabbit ovulation occurs apparently as a result of sexual excitement and depends upon the function of the hypophysis. Pituitary activity in turn constitutes a response to nervous stimulation *via* the infundibular pathway from the hypothalamus. That direct stimulation through the stalk is the important factor is indicated by several lines of evidence. Transection of the stalk prevents ovulation, but does not interfere with copulatory behavior (26). Severance of the sympathetic chains has no effect upon ovulation. Electrical stimulation of the hypothalamus dorsal and rostral to the optic chiasma produces ovulation (49, 50), and direct stimulation of the pituitary has the same effect (49). Injection of copper salts, picrotoxin, or metrazol results in ovulation in the normal estrous doe (27). This effect is probably caused by the activation of a central nervous mechanism which sends impulses to the pituitary. Ovulation does not occur after administration of drugs if the pituitary stalk is sectioned. Infundibular lesions are reported to result in genital atrophy in male and female rabbits (49).

Guinea Pig

There is little direct evidence to indicate the sensory basis of mating behavior of the male or female guinea pig. Overt copulatory behavior of the male guinea pig is normal after sympathetic denervation of the genitals, although ejaculation does not occur

due to paralysis of the smooth muscles of the vas deferens, seminal vesicles, and prostate (**4**). Section of the spinal cord in the male causes erection and ejaculation (**2**). The same phenomena may be produced by applying an electric current to the sacral cord and anus (**13, 40, 63, 64**). According to Magnotti (**58**), removal of the olfactory bulbs in the young male guinea pig is followed by arrest of genital development and inability to reproduce.

The female guinea pig's mating pattern includes one phase of "male-like mounting behavior" and a second type of response involving lordosis and opisthotonos in response to the male's sexual clasp. Both of these phases are dependent upon the synergistic action of estrogen and progesterone, but separate neural mechanisms may be involved (**98**).

Spayed female guinea pigs injected with estrogen and progesterone show normal receptive behavior in response to the male's mounting and clasping reactions despite combined unilateral or bilateral destruction of the neocortex, hippocampus, and the caudate-putamen complex (**35**). Lordosis, opisthotonos, and ovulation are normal in females deprived of 75% of the neocortex, but more extensive decortication in some cases eliminates ovulatory reactions. Destruction of the septal area or the pretectal region has no effect upon ovulation or mating. Mesencephalic invasion destroying the inferior colliculi abolishes receptive behavior and its converse (avoidance reactions during dioestrum), but does not eliminate ovulation. Sexually receptive behavior and ovulation survive section of the pituitary stalk (**34**).

Findings reported by Dempsey and Rioch (**36**) suggest that the neural mechanisms essential to lordosis and opisthotonos in the female guinea pig are located in the brain stem caudal to the anterior margin of the mammillary bodies and rostral to the intercollicular level. These workers observed survival of estrous responses in the female after transection of the brain stem just anterior to the mammillary bodies. A second section anterior to superior colliculus and posterior to the mammillary bodies eliminated sexually receptive responses. Spinal sections from L2 to T5 abolished mating behavior.

Results described by Brookhart, Dey, and Ranson (**24**) localize the central nervous mechanism essential to the integration of the female's mating behavior in the midventral portion of the anterior hypothalamus. These authors conclude that there is no essential mechanism in the region of the mammillary bodies or the mesen-

cephalic tegmentum. They suggest that the results of Dempsey and Rioch (36) were based upon inaccurately localized lesions. Using a modified Horsley-Clark apparatus, Brookhart, Dey, and Ranson placed lesions at the level of the posterior border of the optic chiasma. Spayed female guinea pigs injected with estrogen and progesterone were tested for estrous behavior before and after operation. Injury six millimeters above the ventral surface of the brain had no effect upon mating reactions. Females with lesions one millimeter above the ventral brain surface displayed no sexually receptive responses despite a fourfold increase in the amount of hormone injected.

Brain injury confined to the area between the optic chiasma and the attachment of the infundibular stalk produces any one of four conditions in the female guinea pig. Dey, Fisher, Berry, and Ranson (38) described the results of such destruction as follows: (1) vagina always open, large uteri, follicular ovaries without corpora lutea, estrous behavior in only one case; (2) vagina always open, atrophic uteri, no follicles or corpora lutea, no estrous behavior; (3) normal vaginal and ovarian cycles, estrous behavior in only one case; (4) irregular vaginal cycles, ovaries either completely follicular or completely corpora lutea, estrous behavior greatly reduced or absent.

Rat

Stone (87, 88) reported mating in the male rat subsequent to combined surgical elimination of the receptors mediating the following sensory modalities: vision, olfaction, audition (partial), touch (in the vibrissae), and cutaneous sensitivity of the ventral body wall and scrotum. A more recent investigation (17) indicates that sexually experienced males will continue to copulate after being deprived of any two of three types of sensory receptors: visual, olfactory, and cutaneous (in the snout and lips). Combined elimination of all three modalities eliminates masculine copulatory behavior. Sexually inexperienced males raised in isolation are capable of copulating after loss of vision, olfaction, or cutaneous sensitivity in the snout and lips. After such loss, sexual excitability is reduced. The inexperienced male does not copulate after combined elimination of any two of the above-listed sensory avenues. As a result of these findings Beach (17) concluded that the arousal of sexual excitement in the male rat is not dependent upon stimuli of any one type, but normally occurs as a result of multisensory

stimulation involving the occurrence of central summation and facilitation.

Abdominal sympathectomy is reported by Bacq (**2**) to render the male rat impotent, although the testes are not affected. A low-voltage current applied to the rectum and at the third sacral region of the cord produces erection and ejaculation in the male (**40**). Stone (**93**) observed normal mating behavior in male rats prepubertally deprived of 50% of the cerebral cortex. Davis (**33**) found that after nearly complete decortication some male rats were able to impregnate receptive females. Other males with similar lesions copulated only after injection of testosterone propionate. A third group of cortical operates failed to mate despite administration of male hormone.

Beach (**16**) concluded that injury to the neocortex in the male rat reduces the ease with which sexual arousal occurs but does not interfere with the motor pattern of copulation. The probability of postoperative coition was found to be inversely related to the amount of neopallium destroyed. When lesions did not exceed 40% of the total cortex, postoperative mating was often spontaneous and, in other cases, could sometimes be elicited after administration of testosterone propionate. Males deprived of more than 60% of the cortex did not mate even though massive doses of male hormone were administered. When postoperative mating did occur, the pattern and vigor of the response were normal.

Mating is not abolished in male rats by injury to the supraoptic nuclei, to the median eminence, or by interruption of the hypothalamico-hypophysial connections in the tuberal region (**29**).

Mating in the female rat does not depend upon sensations from the uterus and vagina. Females surgically deprived of these organs display normal receptive behavior (**7**). "Intersexed" female mice treated prenatally with androgens develop no external vagina. Nevertheless, such females display normal ovarian cycles and feminine copulatory behavior (**75**). Diencephalic lesions are reported to cause genital atrophy in the female (**31**). Unilateral hypothalamic injury or destruction confined to the median preoptic area or to the posterior hypothalamus does not disturb the estrous cycles and mating performance of the female. However, "lesions confined to the anterior hypothalamus produce among other abnormalities a change in the estrous cycles and a deficiency of certain reproductive functions of the female rat" (**29**). Infundibular section does not interfere with normal reproductive

cycles, ovulation, mating, or pregnancy in the female rat (**37**).

Removal of as much as 80% of the cerebral cortex does not eliminate copulation and gestation in the female (**93**). Complete decortication abolishes mating in some females, but leaves others capable of coition and gestation (**33**).

Maternal behavior in the female rat survives abdominal sympathectomy, but there is failure of, or reduction in, lactation (**3**). Destruction of varying amounts of cerebral cortex interferes with maternal behavior of the primiparous female (**14**). Quantitative tests on partially decorticated females revealed deficits in one or all of the following phases of maternal behavior: (1) nest-building prepartum, (2) cleaning and collecting of young at parturition, (3) retrieving scattered young to the nest, (4) moving nest and young from under an electric heater, (5) moving nest and young from an air blast. The extent to which an operated female's score fell below averages for the normal control group was roughly proportional to the amount of cortex removed. Restricted injury appeared to interfere with the female's ability to integrate her behavior without abolishing any of the specific reactions tested. There was no clear-cut evidence for localization of any of the abilities observed. Extensive lesions involving two-thirds of the neopallium eliminated maternal reactions.

Stone (**92**), employing similar tests, obtained qualitatively comparable results. Davis (**33**) found no disturbance in maternal behavior after unilateral hemidecortication, but reported elimination of such reactions after bilateral ablation of the cortex. Davis's failure to detect reduction in maternal efficiency after hemidecortication rests upon absence of quantitative tests. His data show merely that the female with a 50% lesion may be capable of bearing and rearing her litter if she is not called upon to adapt to experimentally altered environmental forces.

Cat

Characteristic sex behavior has not been observed in decorticate male cats (**11, 77**), but no complete studies have been reported. That some elements in the masculine mating pattern can be mediated at a spinal level is indicated by the observations of Dusser de Barenne and Koskoff (**41**), who reported that a spinal male placed in a prone position with the hind quarters contacting the table showed priapism. Experiments by Root and Bard (**80**) add to our understanding of spinal mechanisms involved in the male

cat's copulatory performance. Males deprived of the sacral cord and the lower two lumbar segments show erection after they have seized the estrous female. Since in such operates the genitals are anaesthetized, it becomes apparent that afferent impulses from the genitalia are not necessary to penile erection. Complete extirpation of the abdominal chains, or inferior mesenteric ganglionectomy (preceded by lumbosacral removal), eliminates erection but does not impair sexual aggressiveness. Decorticate male cats do not show reflex penile vasodilation in response to manipulation of the genitals (**11**).

Sexual receptivity and normal mating behavior in the female cat is possible after abdominal sympathectomy and removal of the tubes, uterus, and proximal two-thirds of the vagina. An estrous female suffering removal of the sacral cord permits the male to mount, but fails to show the normal treading in response to mechanical stimulation of the vagina. After midthoracic section the female's "foreparts . . . engaged in typical courtship activities." The foregoing observations led Bard (**8**) to conclude that afferent impulses from the vagina are not essential to the female's mating pattern. Removal of the eyes, olfactory bulbs, or cochlea has no effect upon the spayed female's ability to display mating behavior after injections of estrin (**10**).

The female's mating pattern includes rubbing the head and ears against the floor. This reaction may result in vaginal stimulation, for Bradford (**21**) has shown that manual stimulation of the external ear produces contractions of the smooth musculature of the vagina in estrous cats.

Complete decortication coupled with injury to the hippocampus, rhinencephalon, and striatum does not abolish receptivity and mating in spayed female cats injected with estrogen (**9**). The threshold of response to estrin may be raised by such brain injury, however. One female deprived of all neocortex, parts of the rhinencephalon and striatum, and the rostral half of the thalamus showed spontaneous estrus and gave the normal response to vulvar stimulation (crouching, treading, and growling). When in heat this animal attracted males, but resisted their attempts to copulate unless chance stimulation of the vagina occurred, in which case intromission was permitted and normal mating followed (**12**). Apparently, vaginal sensation may contribute to sexual receptivity, although studies cited above indicate that normal mating can occur in the absence of such sensory data.

Ranson (**74**) reported that female cats with "large bilaterally symmetrical lesions in the tuber, lateral to or behind the infundibulum" mate, give birth to normal litters, and suckle their young. Female cats with small lesions in the hypothalamus interrupting the supraoptico-hypophysial tract do not come into estrus and show no mating behavior according to Fisher, Magoun, and Ranson (**43**). The same workers found that female cats suffering hypothalamic lesions producing diabetes insipidus displayed partial or total failure of ability to deliver young. Labor was prolonged and usually fatal.

Magoun and Bard (**59**) observed marked individual difference in the mating responses of female cats subjected to extensive invasion of the hypothalamus and mesencephalon. Removal of the caudal portions of the hypothalamus did not prevent estrual reactions in spayed females injected with estrogen. Destruction of most of the anterior hypothalamus eliminated estrual behavior in one case, but a second female with practically the same type of lesion exhibited well-defined sexual behavior under the influence of estrin. Some evidence indicates a mesencephalic locus for the mechanisms essential to estrous behavior, but Bard (**11**) has described marked reduction in such behavior following the infliction of large lesions confined chiefly to the hypothalamus and invading very little of the midbrain.

Rioch (**77**) concluded that the hormones essential to sexual receptivity in the female cat act upon the central nervous system at some point between the nucleus ruber and striatum and the basal olfactory areas, although neither of these "boundary regions" is essential to mating behavior. Dempsey and Rioch (**36**) localized the mechanisms controlling mating in the brain stem caudal to the anterior margin of the mammillary bodies and rostral to the intercollicular level. Observations reported by Bard (**10**) show that after decerebration at the pontile or low mesencephalic level both estrous and nonestrous female cats respond to vaginal stimulation with collapse of the extensor rigidity of the forelegs. This response, not shown by males and evoked in the female only by vulvar stimulation, results in a posture similar to the copulatory crouch of the intact estrous female. Bard suggests the possibility that the crouch of the decerebrate female reveals a primitive bulbospinal mechanism mediating a major postural adjustment of estrus. Since the response occurs at any stage in the estrous cycle, the mechanisms involved do not depend upon hormonal sensitization. The fore-

going analysis, if correct, indicates, according to Bard, that estrin activates higher centers which elaborate and integrate the phasic items in the female's reproductive pattern.

The findings of Maes (**55, 57**) indicate conclusions opposed to those of Rioch, Dempsey and Rioch, and Bard, cited above. Maes observed sexual treading, opisthotonos, and lateral deviation of the tail in female cats subjected to transection of the spinal cord at the first cervical level. These reactions, elicited in response to mechanical stimulation of the perineum, were displayed by females showing normal estrus and by spayed animals injected with estrogen. Nonestrous cats or noninjected castrates did not show the behavior. These data indicate that treading, opisthotonos, and lateral deviation of the tail are short arc reflexes dependent upon spinal mechanisms which function only under specific hormonal stimulation. Maes suggests that in the female cat's mating pattern higher centers may coördinate independent acts pre-existing at different levels of the brain stem. The absence of estrous reflexes in decerebrate cats studied by Dempsey and Rioch (**36**) was probably due to decerebrate rigidity which eliminated the essential normal muscle tone, according to Maes.

Bromiley and Bard (**11**) have confirmed certain aspects of the work performed by Maes. They report, however, that tail deviation is shown by males as well as by females and that the other reactions described by Maes can be elicited in anestrous females. Bromiley and Bard conclude that these behavioral elements are not strictly "estrual" because they appear independently of estrogenic effects. It is possible, however, that estrogen produces a quantitative increase in such reactions (**11**).

Although the exact locus of action of estrogen is debatable, its influence apparently need not be exerted *via* the pituitary. Maes (**56**) found normal heat behavior in hypophysectomized female cats injected with estrogen.

Dog

Von Bechterew (**96**) produced erection in the dog by electrical stimulation of the cortex. Erection and ejaculation are elicited by the application of an electric current to the lower cord and anus (**48**). Erection and ejaculation can be evoked by genital stimulation after complete section of the cord at the supralumbar level (**11**). Following lumbar section, manipulation of the genitals elicits a series of reactions in the male dog which is highly suggestive of

copulatory behavior. They include bilateral extension at the knees, ankles, and hip joints, depression of the tail, and downward curving of the pelvic portion of the body (82). These responses, which cannot be evoked in the bitch, suggest a spinal integration of independent reactions involved in the normal mating behavior of the intact male.

That higher nervous centers contribute to sexual behavior is indicated by the report of Goltz (47) that a partially decerebrate male dog showed no interest in the rutting female, and by the fact that mating behavior has not been observed in decerebrate males (11). It is difficult to elicit reflex penile vasodilation in decerebrate dogs by mechanical stimulation of the genitalia (11).

Decerebrate female dogs in estrus do not show collapse of extensor rigidity of the forelegs in response to vaginal stimulation (11). The significance of this observation lies in the fact that such responses are elicitable in the spinal cat, and the resulting posture closely resembles the sexual crouch characteristic of the feline copulatory pattern. The feminine canine copulatory response does not include the sexual crouch.

Normal estrus, mating, gestation, and maternal care in a bitch suffering complete lumbar section have been reported by Goltz (46).

Subhuman Primates

Klüver and Bucy (52, 53) reported "hypersexuality" produced in the macaque by bilateral removal of the temporal lobes. Male monkeys suffering such brain injury exhibited pronounced priapism, greatly increased manual and oral masturbation, excessive homo- and heterosexual intercourse. Females repeatedly displayed sexual presentation responses, and one case showed this reaction despite ovariectomy and hysterectomy. Unilateral temporal lobectomy, or bilateral removal of other brain areas, did not produce these alterations in sexual behavior.

No operative studies of reproductive behavior in anthropoids have been reported, but evidence indicates that the organization of copulatory activities in the chimpanzee depends upon individual experience. One of the most exhaustive studies of mating behavior in the chimpanzee was performed by Bingham (19). An inexperienced male was totally unable to achieve coition with a receptive female. Erection occurred readily, but intromission was not even attempted until the more experienced female lent active assistance. Prepubertal sex play occurs frequently among immature chim-

panzees of both sexes, and the organization of the reproductive act is gradually perfected as a result of practice.

Maternal behavior does not appear in well-developed form without opportunity for practice. Yerkes (**97**) has observed that primiparous chimpanzees may not accept or care for their first-born young. Instead, some inexperienced mothers "behave as if surprised, bewildered and lacking in suitable ready-to-hand patterns of behavior." They fail to eat the afterbirth. Multiparous females eat at least a part of the afterbirth and treat the infant as a familiar object.

Man

Reflex erection in the male human is not dependent upon the functional integrity of the neopallium, for it occurs in infants before myelinization and growth of the cortex are complete. The existence of spinal centers controlling erection and ejaculation is indicated by the appearance of these reflexes in man in response to genital stimulation after supralumbar transection of the cord (**11**).

At the same time there is evidence for the importance of higher nervous mechanisms in copulatory behavior. Stier (**86**) reported complete or noticeable loss of libido and potency in 30 of 33 men suffering head trauma in which the diencephalon was the focus of damage. Many cases were totally impotent. Others were capable of intercourse at rare intervals, but found the act excessively long and exhausting. Symonds (**94**) found that brain injury involving structures comprising the floor of the third ventricle may be followed by loss of sexual desire and potency.

The importance of social conditioning in human sex life is undoubtedly great, but admittedly difficult to evaluate. There is some evidence to indicate that the overt expression of libido is dependent upon social training. It may be significant to note that cases of feral man seem to reflect low sex drive rather than high sexual excitability. Several reports reveal almost total lack of interest in sexual matters on the part of the adult males Tomko of Zips and Kaspar Hauser. The wolf-children of Nidnapore, the wild-boy of Aveyron, Kamala, and the wild-boy of Kronstadt appear to have exhibited certain restlessness and "unpatterned behavior" at the onset of puberty, but there are no reports of sex offenses. These fragmentary data lead one to agree with Zingg's suggestion that in human beings "the social channeling of sex is much more necessary for its full expression than might be thought" (**99**).

Although in man as in the other vertebrates sexual impulses

are intimately associated with secretions of the sex glands, human libido may persist in the absence of such endocrine factors. One case of normal and regular intercourse nine years after postpubertal castration of a male patient is described by Rowe and Lawrence (**81**). In another instance normal masculine copulatory behavior is reported to have survived 20 years after gonadectomy (**95**). Feinier and Rothman, as reported in Moehlig (**62**), recorded a case involving complete retention of libido and copulatory ability for 30 years following testis removal. The importance of psychic factors in the postcastrate survival of mating behavior has been stressed (**62**). Studies of approximately 300 war-wounded patients convinced Lange (**54**) that libido and potency may be maintained indefinitely after castration. Many patients suffer reduction in, or loss of, potency but retain full libido. A few cases of heightened libido are reported. In many individuals all sex drive and ability are lost.

In the human female loss of libido and amenorrhoea may follow brain injury involving the floor of the third ventricle (**94**). The importance of genital stimulation to the occurrence of high sexual excitement is well known. Friedgood (**45**) reports restoration of sexual desire, occurrence of "libidinous feeling," and cessation of amenorrhoea after faradization of the cervix in a patient whose ovarian cycles and libido had been absent for seven years. Although endocrine therapy had proven unsuccessful in this case, faradic stimulation of the cervix (seven treatments) was followed by three years of fairly normal menstrual cycles and sex desire.

Ovariectomy in the human usually produces a gradual loss of desire for intercourse and elimination of the pleasurable sensations associated with coitus; but in some cases these functions are retained (**60**). Sensations of orgasm may survive castration in women (**32, 44**).

Discussion and Conclusions

Although experimental evidence is incomplete, the data summarized in the present review suggest several relationships between patterns of reproductive behavior and the central nervous system in vertebrates.

Changes in the Form of Reproductive Behavior

The courtship and mating of the lower vertebrates first appear in the individual soon after the occurrence of physiological ma-

turity; and throughout the reproductive span the behavior patterns are executed in fairly stereotyped fashion. It is apparent that innately organized mating and parental responses are not subject to extensive modification as a result of individual experience. Fish that display elaborate courtship and definite parental behavior do so without opportunity for learning, and the patterns show little or no evidence of individual modification. If environmental conditions are altered during courtship, spawning is disrupted. If the fish with young is disturbed, the fry are either eaten by the parent or left to die of neglect.

The courtship behavior and parental care of many species of birds are only slightly more modifiable than those of the fish, amphibian, and reptile. Mating is relatively stereotyped, and experimental alteration of the appearance of one of the pair frequently prevents courtship. Care of the young proceeds only so long as pronounced environmental interference does not occur. If the nest is disturbed or the sensory qualities of the young modified, the parent is apt to desert the brood and start a new nest and clutch elsewhere.

In some lower mammals, such as the rat, responses involved in mating and care of the young are innately organized. The behavior patterns appear without opportunity for learning and customarily proceed in a more or less stereotyped fashion. If, however, it becomes necessary for the individual to diverge from the inherited pattern, such adjustment is possible. The primiparous rat is capable of choosing a dark nest site for parturition, building a good nest, cleaning and collecting the young, etc. If the nest site is made untenable by experimental alteration of environmental conditions, the female does not desert her litter, but moves the young and rebuilds the nest in a more suitable location. The ability to modify inherited behavior on the basis of individual experience is dependent upon the function of the cerebral cortex, which is nonexistent or rudimentary in the brains of lower vertebrates but highly developed in mammals. Extensive injury to the neocortex may leave the female rat able to carry out her maternal duties in a stereotyped fashion, but renders her incapable of modifying parental responses to adjust to environmental changes. It is of interest to note that female rats which score above average on tests of maternal behavior also rank above average in maze-learning ability (**15**).

The reproductive behavior of the highest vertebrates is ap-

parently not completely organized on an inherited level. In primates mating responses and care of the young are not only subject to, but at least partially dependent upon, learning.

During the evolution of vertebrates reproductive behavior has undergone a gradual change. Stereotyped inherited forms of reproductive behavior have been replaced by innately organized patterns subject to ontogenetic modification; and these in turn have broken down so that the organization of the complete mating or parental pattern is not inherited but must be filled out through individual experience. These changes have taken place concomitantly with the gradual increase in size and specialization of the forebrain. The modifiability of reproductive behavior in the lower mammals is apparently associated with the acquisition of the cortex. Increasing dependence upon individual experience, as contrasted with reliance upon innately organized response patterns, goes hand in hand with progressive growth and differentiation of neopallium.

Sensory Basis of Mating

The reproductive behavior of lower vertebrates appears to depend heavily upon sensory stimuli mediated by a single type of receptor. Blind fish of several species are practically incapable of courtship and mating. The blind male frog does not mate unless chance contact with the gravid female occurs. This tendency for one type of sensory data to dominate the reaction possibilities of lower vertebrates is not restricted to reproductive activity, but is revealed in all types of behavior. Because of their nearly complete dependence upon a single sensory modality the blind frog, the anosmic shark, and the blind lizard starve to death in the midst of an adequate food supply.

Although birds are somewhat less dependent upon any one type of sensory stimulation than are most species of fish, amphibia, and reptiles, the birds tend to rely chiefly upon vision for orientation of their reproductive activity. The blind male pigeon may court the female, but is unable to copulate effectively. The female pigeon's ovulatory cycle is initiated exclusively by visual cues.

In sharp contrast to the mating activity of the lower vertebrates the reproductive behavior of mammals is independent of any one type of sensory stimulation. Male rodents, carnivores, and primates are capable of mating normally in the absence of vision, audition, olfaction, or cutaneous sensitivity in the sex zones.

Whereas no single type of stimulus is essential to the activation of the mating responses, there is evidence that several kinds of sensory data contribute to the arousal of sexual excitement and the consequent occurrence of mating. Mating in the female mammal appears to be equally independent of restricted sensory cues, for removal of nearly all exteroceptors does not eliminate the female's copulatory response.

These differences in the sensory basis of mating in various classes of vertebrates are directly correlated with variations in the structure of the brain in each species. Each area in the forebrain of the lower vertebrates is "dominated by a single functional system" (**51**). Every group of cells is directly connected to an effector or receptor system. The forebrain of the frog is devoid of "association areas," regions free from the dominance of single sensory systems. The mammalian forebrain includes numerous association areas connected indirectly with several peripheral receptors and providing a physical basis for the interaction of multisensory stimuli.

In general it appears that, as the size and degree of differentiation of the forebrain have increased, vertebrates have become less dependent upon single types of sensory data. Many reactions including mating have come to be evoked by combinations of stimuli rather than by discrete unisensory cues. This change in behavior has occurred simultaneously with the appearance of forebrain association areas receiving impulses from several independent sensory systems and providing the anatomical substratum for multisensory interaction, summation, and facilitation.

Central Nervous Control of Reproductive Behavior

Most of the evidence suggests that in all classes of vertebrates the discrete acts involved in patterns of courtship, mating, and parental care are mediated by nervous mechanisms located in the brain stem and spinal cord. Decerebrate fish, amphibia, reptiles, birds, and mammals are apparently capable of all motor adjustments necessary to the execution of such behavior. Furthermore, destruction of the cerebrum in any of these forms does not drastically reduce the animal's simple sensory capacities. Findings of neuroanatomists would not lead us to suspect that the decerebrate vertebrate is totally blind, anosmic, deaf, or deprived of somatic sensitivity. If after removal of the cerebrum the animal can see, hear, taste, smell, and feel, as well as execute all of the overt re-

sponses necessary to reproduction, why does extensive injury to the forebrain seriously interfere with, or completely abolish, reproductive behavior? An attempt to answer this question involves consideration of the general effects of forebrain injury upon reproduction in vertebrates of different classes. Certain effects found in several classes give some indication as to the function of the forebrain in reproductive behavior.

One of the most widely observed results of extensive forebrain lesions upon reproductive behavior throughout the vertebrate scale is the tendency for such brain injury to result in complete or partial disintegration of the pattern of response. All discrete elements in the pattern may survive after operation, but the spatial and temporal organization of their serial execution is lost. General recognition of this effect is reflected in the writings of several investigators. Noble (**66, 72, 73**) concluded that the forebrain is essential to organization of the pattern of reproductive behavior in several species of fish. Rogers (**79**) suggested that the forebrain "ties together" the discrete acts involved in the courtship and mating behavior of the pigeon. Beach (**14**) noted disintegration of the maternal behavior pattern in rats suffering cortical destruction. Bard (**10**) concluded that nervous mechanisms above the bulbospinal system elaborate and integrate the phasic elements in the copulatory behavior of the female cat.

A second result of forebrain injury may be the elimination of one or more of the specific elements in the behavior pattern. In most cases the evidence is against localization of function within the forebrain. Various elements in the courtship and mating of cichlid fishes may be eliminated by extensive forebrain removal; but different lesions may produce the same defect. Pursuit and clasping of the female by the male frog can be eliminated by ablation of all forebrain tissue including the preoptic area but not by restricted lesions in the forebrain; and the forebrainless male will execute many other elements in the mating pattern with normal vigor and precision.

Although there has been some attempt to localize within the forebrain of the pigeon certain areas responsible for specific elements in the reproductive pattern, the most impressive aspect of experimental work with birds is the indication that the number of behavioral elements eliminated is a function of the amount of cerebral tissue removed. In the maternal behavior of the rat various elements may drop out after extensive cortical invasion. The

elimination of separate segments of the pattern is a function of the amount of cortex removed rather than a specific locus of the lesion.

A third effect of forebrain injury upon reproductive behavior of vertebrates is a definite reduction in the operated animal's excitability. In some cases this effect may be traced to interference with the interaction between different brain regions. There have been no tests to determine the sexual excitability of male or female fish suffering injury to the forebrain. It is possible that the absence of courtship and spawning in forebrainless fish is due to greatly lowered sexual excitability consequent to brain injury. Somewhat comparable indications are found in some data on amphibia. In the male frog neither the forebrain nor the preoptic area is essential to pursuit and clasping of the gravid female. Separate elimination of either of these brain regions does not affect such behavior. However, combined destruction immediately eliminates the male's ability to pursue and clasp the female (save in the special case of tactile stimulation). Forebrain removal reduces responsiveness to many types of stimuli. Destruction of the preoptic area involves injury to the anterior commissure which carries olfactory fibers to the forebrain. Deprived of part of its fiber supply, the activity of the forebrain is markedly reduced, and this reduction is reflected in the frog's lowered excitability.

Studies on the copulatory behavior of male rats deprived of varying amounts of neopallium strongly suggest that cortical tissue contributes to the mediation of sexual excitability without contributing directly to the overt mating pattern. This effect apparently depends upon the elimination or reduction of the possibility for cortically mediated intersensory summation and facilitation.

BIBLIOGRAPHY

1. ALBERTONI, P. Expériences sur les centres nerveux inhibiteurs du crapaud. *Arch. ital. Biol.*, 1888, **7**, 19–20.
2. BACQ, Z. M. Impotence of the male rodent after sympathetic denervation of genital organs. *Amer. J. Physiol.*, 1931, **96**, 321–330.
3. BACQ, Z. M. The effect of sympathectomy on sexual functions, lactation, and the maternal behavior of the albino rat. *Amer. J. Physiol.*, 1932, **99**, 444.
4. BACQ, Z. M., & BROUHA, L. Recherches sur la physiologie du système nerveux autonome. II. Le comportement des organes génitaux après énervation sympathetique. *Arch. int. Physiol.*, 1933, **35**, 250–285.
5. BAGLIONI, S. Modifications produites par l'embrassement sur les fonctions centrales du crapaud, les centres nerveux qui president à l'embrassement chez le crapaud. *Arch. ital. Biol.*, 1911, **56**, 448–450.

6. BAGLIONI, S. Physiologie des Nervensystems. II. Amphibia. *Handb. vergl. Physiol.*, 1913, **4**, 353–413.
7. BALL, J. Sex behavior of the rat after removal of the uterus and vagina. *J. comp. Psychol.*, 1934, **18**, 419–422.
8. BARD, P. The effects of denervation of the genitalia on the oestrual behavior of cats. *Amer. J. Physiol.*, 1935, **113**, 5.
9. BARD, P. Oestrual behavior in surviving decorticate cats. *Amer. J. Physiol.*, 1936, **116**, 4–5.
10. BARD, P. Central nervous mechanisms for emotional behavior patterns in animals. *Res. Publ. Ass. nerv. ment. Dis.*, 1939, **19**, 190–218.
11. BARD, P. The hypothalamus and sexual behavior. In *The Hypothalamus and Central Levels of Autonomic Function. Res. Publ. Ass. nerv. ment. Dis.*, 1940, **20**, 551–579.
12. BARD, P., & RIOCH, D. MCK. A study of four cats deprived of neocortex and additional portions of the forebrain. *Johns Hopk. Hosp. Bull.*, 1937, **60**, 73–147.
13. BATELLI, F. Une méthode pour obtenir l'émission complète du liquide des vésicules séminales chez le cobaye. *C. R. Soc. Phys. Hist. nat. Genève*, 1922, **39**, 73–74.
14. BEACH, F. A. The neural basis of innate behavior. I. Effects of cortical lesions upon the maternal behavior pattern in the rat. *J. comp. Psychol.*, 1937, **24**, 393–439.
15. BEACH, F. A. The neural basis of innate behavior. III. Comparison of learning ability and instinctive behavior in the rat. *J. comp. Psychol.*, 1939, **28**, 225–262.
16. BEACH, F. A. Effects of cortical lesions upon the copulatory behavior of male rats. *J. comp. Psychol.*, 1940, **29**, 193–245.
17. BEACH, F. A. Analysis of the stimuli adequate to elicit mating behavior in the sexually inexperienced male rat. *J. comp. Psychol.*, 1942. (In press.)
18. BERK, L., CHEETHAM, R. W. S., & SHAPIRO, H. A. The biological basis of sexual behavior in amphibia. III. The role of distance receptors in the establishment of the mating reflex (coupling) in *Xenopus laevis* (South African Clawed Toad): the eyes. *J. exp. Biol.*, 1936, **13**, 60–63.
19. BINGHAM, H. C. Sex development in apes. *Comp. Psychol. Monogr.*, 1929, **5**, 1–165.
20. BLANKENAGEL, F. Untersuchungen ueber die Grosshirnfunktionen von *Rana temporaria*. *Zool. Jb.* (*Physiol.*), 1931, **49**, 271–322.
21. BRADFORD, F. K. The auriculo-genital reflex in cats. *Quart. J. exp. Physiol.*, 1938, **27**, 271–279.
22. BREDER, C. M., JR. An experimental study of the reproductive habits and life history of the cichlid fish, *Acquidens latifrons* (Steindachner). *Zoologica, N. Y.*, 1934, **18**, 1–42.
23. BROMILEY, R. B., & BARD, P. Unpublished results cited in Bard (**11**).
24. BROOKHART, J. M., DEY, F. L., & RANSON, S. W. Failure of ovarian hormones to cause mating reactions in spayed guinea pigs with hypothalamic lesions. *Proc. Soc. exp. Biol., N. Y.*, 1940, **44**, 61–64.
25. BROOKS, C. MCC. The role of the cerebral cortex and of various sense organs in the excitation and execution of mating activity in the rabbit. *Amer. J. Physiol.*, 1937, **120**, 544–553.

26. Brooks, C. McC. A study of the mechanism whereby coitus excites the ovulation-producing activity of the rabbit's pituitary. *Amer. J. Physiol.*, 1938, **121**, 157–177.
27. Brooks, C. McC., Beadenkopf, W. G., & Bojar, S. A study of the mechanism whereby copper acetate and certain drugs produce ovulation in the rabbit. *Endocrinology*, 1940, **27**, 878–882.
28. Brooks, C. McC., & Lambert, E. E. The effect of hypophysial stalk transection on the gonadotropic functions of the rabbit's hypophysis. *Amer. J. Physiol.*, 1939, **128**, 57–69.
29. Brooks, C. McC., & Leonard, W. E. Effect of hypothalamic lesions on the estrous cycle of the rat. (Abstract.) *Progr. Ass. Stud. intern. Secretions*, 1941, 13.
30. Burnett, T. G. Some observations on decerebrate frogs, with special reference to the formation of associations. *Amer. J. Physiol.*, 1912, **30**, 80–87.
31. Cahane, M., & Cahane, T. Sur certaines modifications des glandes endocrines après une lésion diencephalique. *Rev. franç. Endocrin.*, 1936, **14**, 472–487.
32. Clauberg, C., & Schultze, K. W. Die Folgen der Sterilisierung und der Kastration bei Mann und Frau. *Z. ärztl. Fortbild.*, 1934, **31**, 425.
33. Davis, C. D. The effect of ablations of neocortex on mating, maternal behavior and the production of pseudopregnancy in the female rat and on copulatory activity in the male. *Amer. J. Physiol.*, 1939, **127**, 374–380.
34. Dempsey, E. W. The relationship between the central nervous system and the reproductive cycle in the female guinea pig. *Amer. J. Physiol.*, 1939, **126**, 758–765.
35. Dempsey, E. W., & Rioch, D. McK. Oestrous behavior in guinea pigs without neocortex and other portions of the forebrain. *Amer. J. Physiol.*, 1938, **123**, 52.
36. Dempsey, E. W., & Rioch, D. McK. The localization in the brain stem of the oestrous responses of the female guinea pig. *J. Neurophysiol.*, 1939, **2**, 9–18.
37. Dempsey, E. W., & Uotila, U. U. The effect of pituitary stalk section upon reproductive phenomena in the female rat. *Endocrinology*, 1940, **27**, 573–579.
38. Dey, F. L., Fisher, C., Berry, C. M., & Ranson, S. W. Disturbances in reproductive functions caused by hypothalamic lesions in female guinea pigs. *Amer. J. Physiol.*, 1940, **129**, 39–46.
39. Diebschlag, E. Beobachtungen und Versuche an intakten und grosshirnlosen Eidechsen und Ringelnattern. *Zool. Anz.*, 1938, **124**, 30–40.
40. Durfee, T., Lerner, M. W., & Kaplan, N. The artificial production of seminal ejaculation. *Anat. Rec.*, 1940, **76**, 65–68.
41. Dusser de Barenne, J. G., & Koskoff, V. D. Further observations on flexor rigidity in the hind legs of the spinal cat. *Amer. J. Physiol.*, 1934, **107**, 441–446.
42. Edinger, F. Die Leistungen des Zentralnervensystems beim Frosch dargestellt mit Ruecksicht auf die Lebensweise des Tieres. *Z. allg. Physiol.*, 1913, **15**, 15–64.
43. Fisher, C., Magoun, H. W., & Ranson, S. W. Systocia in diabetes insipidus. The relation of pituitary oxytocin to parturition. *Amer. J. Obstet. Gynaec.*, 1938, **36**, 1–9.

44. FRANK, R. T. The female sex hormone. Baltimore: Thomas, 1929.
45. FRIEDGOOD, H. B. Inanition and nervous system effects on the menstrual cycle. (Abstract.) *Progr. Ass. Stud. intern. Secretions*, 1941, 23.
46. GOLTZ, F. Über den Einfluss des Nervensystems auf die Vorgänge während der Schwangerschaft und des Gebärakts. *Pflüg. Arch. ges. Physiol.*, 1874, **9**, 552.
47. GOLTZ, F. Der Hund ohne Grosshirn. *Pflüg. Arch. ges. Physiol.*, 1892, **51**, 570.
48. GUNN, R. M. C. Fertility in sheep: artificial production of seminal ejaculation and the characters of the spermatozoa contained therein. *Commonw. Aust. Coun. sci. industr. Res. Bull.*, 1935, No. 94.
49. HARRIS, G. W. The induction of ovulation in the rabbit by electrical stimulation of the hypothalamohypophysial mechanism. *Proc. roy. Soc.*, 1937, **122**, 374–394.
50. HATERIUS, H. O., & DERBYSHIRE, A. J. Ovulation in the rabbit following stimulation of the hypothalamus. *Amer. J. Physiol.*, 1937, **119**, 329–330.
51. HERRICK, C. J. Neurological foundations of behavior. New York: Holt, 1924.
52. KLÜVER, H., & BUCY, P. C. A preliminary analysis of the functions of the temporal lobes in monkeys. *Trans. Amer. neurol. Ass.*, 1939, 170–175.
53. KLÜVER, H., & BUCY, P. C. Preliminary analysis of functions of the temporal lobes in monkeys. *Arch. Neurol. Psychiat., Chicago*, 1939, **42**, 979–1000.
54. LANGE, J. Die Folgen der Entmannung Erwachsener an des Hand der Kriegerserfahrungen dargestellt. Leipzig: Thieme, 1934.
55. MAES, J. P. Neural mechanism of sexual behavior in the female cat. *Nature, Lond.*, 1939, **144**, 598–599.
56. MAES, J. Hypophysectomie et comportement sexuel de la chatte. *C. R. Soc. Biol. Paris*, 1940, **133**, 92–94.
57. MAES, J. Le méchanisme nerveux du comportement sexuel de la chatte. *C. R. Soc. Biol. Paris*, 1940, **133**, 95–97.
58. MAGNOTTI, T. L'importanza dell'olfatto sullo sviluppo e funzione degli organi genitali. *Boll. Mal. Orecch.*, 1936, **8**, 281–293.
59. MAGOUN, H. W., & BARD, P. Unpublished experiments. Cited in Bard (**11**).
60. MALLOW, S. Beitrag zur Kastration von Sexualverbrechern. *Z. ges. Neurol. Psychiat.*, 1933, **148**, 501.
61. MATTHEWS, L. H. Visual stimulation and ovulation in pigeons. *Proc. roy. Soc.*, 1939, **126**, 557–560.
62. MOEHLIG, R. C. Castration in the male. Notes on the hypothalamico-pituitary-gonadal system. *Endocrinology*, 1940, **27**, 743–748.
63. MOORE, C. R. Seminal vesicle and prostate function as a test. *Amer. J. Anat.*, 1930, **45**, 39–69.
64. MOORE, C. R., & GALLAGHER, T. F. On the prevention of castration effects in mammals by testis extract injection. *Amer. J. Physiol.*, 1929, **89**, 338–394.
65. NOBLE, G. K. Experimenting with the courtship of lizards. *Nat. Hist., N. Y.*, 1934, **34**, 3–15.
66. NOBLE, G. K. Effect of lesions of the corpus striatum on the brooding behavior of cichlid fishes. (Abstract.) *Anat. Rec.*, 1937, **70**, No. 1, Suppl. 1.
67. NOBLE, G. K. Sexual selection among fishes. *Biol. Rev.*, 1938, **13**, 133–158.
68. NOBLE, G. K. Neural basis of social behavior in vertebrates. *Coll. Net*, 1939, **14**, 121–124.

69. NOBLE, G. K., & ARONSON, L. R. The sexual behavior of Anura. II. The neurological bases of mating in male *Rana pipiens*. (Manuscript in preparation.)
70. NOBLE, G. K., & BORNE, R. The effect of forebrain lesions on the sexual and fighting behavior of *Betta splendens* and other fishes. *Anat. Rec.*, 1941, **79**, No. 3, Suppl. 2, 49.
71. NOBLE, G. K., & BRADLEY, H. T. The mating behavior of lizards; its bearing on the theory of sexual selection. *Ann. N. Y. Acad. Sci.*, 1933, **35**, 25–100.
72. NOBLE, G. K., & CURTIS, B. The social behavior of the Jewel Fish, *Hemichromis bimaculatus* Gill. *Bull. Amer. Mus. nat. Hist.*, 1939, **76**, 1–46.
73. NOBLE, G. K., KUMPF, K. F., & BILLINGS, V. N. The induction of brooding behavior in the Jewel Fish. *Endocrinology*, 1938, **23**, 353–359.
74. RANSON, S. W. The hypothalamus: its significance for visceral innervation and emotional expression. (The Weir Mitchell Oration.) *Trans. Coll. Phys. Philad.*, 1934, **2**, 222–242.
75. RAYNAUD, A. Comportement sexuel des souris femelles intersexuées. *C. R. Soc. Biol. Paris*, 1938, **127**, 993–995.
76. REEVES, C. D. The breeding habits of the Rainbow Darter (*Etheostoma coeruleum* Storer): a study in sexual selection. *Biol. Bull. Wood's Hole*, 1907, **14**, 35–39.
77. RIOCH, D. McK. Certain aspects of behavior in decorticate cats. *Psychiatry*, 1938, **1**, No. 3.
78. RIOCH, D. McK. Neurophysiology of the corpus striatum and globus pallidus. *Psychiatry*, 1940, **3**, 119–139.
79. ROGERS, F. T. Studies of the brain stem. VI. An experimental study of the corpus striatum of the pigeon as related to various instinctive types of behavior. *J. comp. Neurol.*, 1922, **35**, 21–60.
80. ROOT, W. S., & BARD, P. Erection in the cat following removal of lumbo-sacral segments. *Amer. J. Physiol.*, 1937, **119**, 392–393.
81. ROWE, A. W., & LAWRENCE, C. H. Studies of the endocrine glands. IV. The male and female gonads. *Endocrinology*, 1928, **12**, 591.
82. SCHÄFER, E. A. Text-book of physiology. New York: Macmillan, 1900. Vol. II, pp. 783–883.
83. SCHRADER, M. E. G. Zur Physiologie des Froschgehirns. *Pflüg. Arch. ges. Physiol.*, 1887, **41**, 75–90.
84. SCHRADER, M. E. G. Zur Physiologie des Vogelhirns. *Pflüg. Arch. ges. Physiol.*, 1889, **44**, 175–238.
85. SCHRADER, M. E. G. Ueber die Stellung des Grosshirns im Reflexmechanismus des centralen Nervensystems der Wirbelthiere. *Arch. exp. Path. Pharmak.*, 1892, **29**, 55–118.
86. STIER, E. Disturbances of sexual functions through head trauma. *Dtsch. med. Wschr.*, January 28, reviewed in *J. nerv. ment. Dis.*, 1938, **88**, 714–715.
87. STONE, C. P. Congenital sexual behavior of young male albino rats. *J. comp. Psychol.*, 1922, **2**, 95–153.
88. STONE, C. P. Further study of the sensory functions in the activation of sexual behavior in the young male albino rat. *J. comp. Psychol.*, 1923, **3**, 469–473.
89. STONE, C. P. The effects of cerebral destruction on the sexual behavior of rabbits. I. The olfactory bulbs. *Amer. J. Physiol.*, 1925, **71**, 430–435.

90. STONE, C. P. The effects of cerebral destruction on the sexual behavior of rabbits. II. Frontal and parietal regions. *Amer. J. Physiol.*, 1925, **72**, 372–385.

91. STONE, C. P. The effects of cerebral destruction upon the sexual behavior of male rabbits. III. The frontal, parietal, and occipital regions. *J. comp. Psychol.*, 1926, **6**, 435.

92. STONE, C. P. Effect of cortical destruction on reproductive behavior and maze learning in albino rats. *J. comp. Psychol.*, 1938, **26**, 217–236.

93. STONE, C. P. Sex drive. *In* Allen, E., Danforth, C. H., & Doisy, E. A. (Eds.), *Sex and Internal Secretions: A Survey of Recent Research.* (2nd ed.) Baltimore: Williams & Wilkins, 1939. Pp. 1213–1262.

94. SYMONDS, C. P. Concussion and contusion of the brain and their sequelae. *In* Brock, S. (Ed.), *Injuries of the Skull and Spinal Cord.* Baltimore: Williams & Wilkins, 1940. Pp. 69–111.

95. TANDLER, J., & GROSZ, S. Über den Einfluss der Kastration auf den Organismus: II. Die Skopzen. *Arch. EntwMech. Org.*, 2 Teil, 1910, **30**, 236.

96. VON BECHTEREW, W. Die Funktionen der Nervencentra. Deutsche Ausgabe in Verbindung mit dem Verfasser redigiert durch Dr. Richard Weinberg. Jena: Gustav Fischer, 1911. Vol. 3.

97. YERKES, R. M. Laboratory chimpanzees. *Science*, 1940, **91** (2362), 336–337.

98. YOUNG, W. C., DEMPSEY, E. W., HAGQUIST, C. W., & BOLING, J. L. Sexual behavior and sexual receptivity in the female guinea pig. *J. comp. Psychol.*, 1939, **27**, 49–68.

99. ZINGG, R. M. Feral man and cases of isolation. *Amer. J. Psychol.*, 1940, **53**, 487–517.

PSYCHOLOGICAL EXAMINING IN THE UNITED STATES NAVY: AN HISTORICAL SUMMARY[1]

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In the classic Memoir Number 15 of the National Academy of Sciences, which describes in great detail the history of the Army testing program under the direction of Dr. R. M. Yerkes (**57**), no mention is made of the Navy. This omission is understandable, but the fact that the method was not used in connection with the enlistment of naval personnel is surprising. However, the implication of Yerkes' (**56**) report to the National Research Council is that, with the exception of Raymond Dodge, no work was done by psychologists for the Navy during World War I. It had been my belief, perhaps due entirely to ignorance, that no kind of psychological examining had been used by the Navy. Upon going on active duty at the Naval Medical School in October, 1940, in connection with a program of clinical psychology as a part of a broader psychiatric program in recruit selection, I undertook to search for possible earlier work. To my surprise I found that a number of medical officers had devised intelligence tests and that at least three of these had had wide application. None of these tests are mentioned by Hildreth (**20**), and it seems likely they are relatively unknown to psychologists. My own interest has suggested that an historical note might be welcome.

This summary has no claim to absolute completeness; the files of the *Naval Medical Bulletin* have been carefully searched, the *U. S. Naval Institute Proceedings* have been sampled, and a few publications elsewhere have been considered, but it is quite possible that an important paper has been overlooked. Furthermore, consideration is limited to papers dealing directly with psychological examinations. Articles such as those of Bieg (**5**), Durr (**16**), Taussig (**48**), and Thorpe (**52**) during the World War, and of Henning (**19**), Thom (**49**), and Cottle (**10**) at a later date, are interesting analyses of naval personnel problems having a psychological significance, but as they do not involve examination methods we will not consider them.

The bulk of the material found has to do with measurement of

[1] The opinions expressed are those of the author only and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

intelligence of recruits. History methods are frequently alluded to, especially in connection with more specifically psychiatric examinations. Finally, there are a few instances of reports on psychological methods being used for particular kinds of selection.

Recruit Selection

As early as 1912 Lowndes (**25**) remarks that "much has been written of late concerning the mental examination of the recruit," although he does not cite references, and he personally doubted the value of such examinations. The following year Schier (**34**) reported on the use of the Binet-Simon scale in the detection of feeble-mindedness among recruits, and during the next decade there were a number of comments on the use of this test in recruiting. Stokes (**46**), Bostick (**7**), and Sheehan (**38, 39, 40**) agree that, while the Binet scale gave *a priori* promise, it was not well adapted to service use because of its length, indefinite findings, variations among examiners, and similar criticisms. Ratcliff (**30**) reports that the test was used in a psychiatric study of 1500 men and served to detect men of inferior ability. Goddard (**18**) describes a short form of the Binet, including three or four items in each year from X to XVIII, but he gives no indication that the scale was ever used in the Naval Service. The primary purpose of the Binet and of the tests about to be described was the elimination of mentally deficient recruits. Nearly all of the authors preface the description of their test with a discussion of the dangers of admitting mentally subnormal men to the Navy. This was, of course, one of the first interests of the psychological examining in the Army, but apparently wholesale examinations were not made in the Navy until some years after the War.

Special Examinations

I have found nine papers describing tests which were actually used in the Naval Service. While some of these tests were given to relatively large groups of men, the data are usually inadequately reported, and the details are now of historical interest only. It is pertinent, however, to describe the tests briefly to indicate the efforts that were made.

The earliest test was published by Butts (**8**), who acknowledges the help of S. I. Franz and says that the test was used with 528 Navy and Marine Corps personnel at St. Elizabeth's Hospital. His special mental examination included the following six tests: (1) remote memory by re-

call of facts of history, geography, etc.; (2) brief delayed recall: subject is told a brief statement, *e.g.* an address, and warned that he will be asked for it in five minutes; (3) mental arithmetic including computation and simple problem-solving; (4) reading and report: three stories are read to subject and he is asked to reproduce them in his own words; (5) reasoning and judgment: giving differences and meaning of proverbs; (6) ethical questions.

Schier (**35**), who in 1913 reported on the use of the Kuhlmann-Binet in Marine Corps recruiting, in 1914 published an original test utilizing Binet items. The 10 items in his scale were: (1) repetition of seven digits; (2) drawing designs from memory; (3) sentence-building from three words given; (4) oral computation; (5) Healy puzzle A; (6) definition of abstract words; (7) recognition of absurdities; (8) problems of fact; (9) reading and report; (10) reversing clock hands. Passing of 7 of these items was taken as the acceptable minimum. His data showed that a group of normals passed an average of 8.78 tests while a group of institutionalized feeble-minded passed only 4.72. In a later paper Schier (**36**) proposed a system of point-scoring in order to allow partial credits for each item. However, in 1917 he reported (**37**) an experimental comparison of the two scoring methods and concluded that his earlier minimum of 7 passes was more practical than the point method. Thomas (**51**) examined 300 prisoners at the Portsmouth Naval Prison with the Schier test and also concluded that the 70% standard was satisfactory. In an earlier paper Thomas (**50**) reported the examination of 3000 prisoners and 100 Marines. Of the former, 28% failed while only 12% of the Marines failed. He also found a definite relation between military efficiency ratings of the Marines and the Schier test scores.

Jenkins (**22**) says that the Schier test was used during 1914 at the Naval Disciplinary Barracks, Port Royal, South Carolina. He, however, later made modifications which are described in this paper. Items 1 to 4 and 6 to 7 given in the Schier list above were used; the Seguin formboard was substituted for Healy puzzle A; and the following new tests were added: inkblot, Knox moron test, counting forward and backward from 1 to 20, imaginary situations, and syllogisms (reasoning problems). His scoring standard was 9 passed; his normal group passed 10.9 items, and a feeble-minded control group passed only 6.6 items.

McMullin (**27**) describes a test used at the Recruiting Office, Buffalo, New York. This test included six items: repeating of seven digits; sentence-building using three words given; differences between president and king, or definition of abstract words; simple opposites; code (not from the Binet); and drawing designs from memory. The scoring standard was 70% passed.

Goddard (**18**) says that Professor Mellville had examined 17 men at the Seamen's Barracks, Philadelphia, with a scale of 12 items, of which 11 were from the Binet. No further information about this test is given.

Bisch (**6**), in an extensive report on neurological and psychological examinations given at the Naval Operating Base, Hampton Roads, Virginia, describes a very short test and a unique method of administration designed to conserve time. His test items were: Knox cube, three to six

digits backward, Healy puzzle A, and Binet comprehension questions. For administration of the series five yeomen were used. The first man took a brief history, and each of the other four gave and scored one of the tests. Thus, five men were being examined at one time with an average time per man-test of three minutes. The scoring was based on a point system with a maximum of 84. Two samples of 1000 recruits had average scores of 51.41, and a group of 1000 men from an armed guard outfit had a score of 58.71. The critical lower minimum was determined to be 30. The scores gave a correlation with the man's own claim of amount of schooling of $r = 0.35$. McDaniel (**26**) very briefly reported data on approximately 13,000 men examined with this test at the Naval Training Station, Hampton Roads, during 1918 and 1919. The average score was 49.14.

In an anonymous note (**1**) in the "Queries" section of the *Naval Medical Bulletin* the editor says that he received simultaneously a request for information regarding psychological tests for recruiting use (this in spite of all the earlier literature) and a test suggested for this purpose. This test included digits forward, a simplified code test using only the first figure of the Binet code, the Knox cube, and a series of orientation and information questions. No indication is given that this test was ever in actual use.

Poppen (**29**), writing on mental selection in recruiting service, says that tests based on education are unsatisfactory and that naval personnel should be better than average. He describes a five-item test which had been administered to 278 applicants. Of these, 74.1% passed; of those who failed, 15 were rejected on the mental ability basis alone. Without the use of the test only 2 of these, 15 men would have been detected. His five items were: repeating digits backward, difference between president and king, problems of fact, and arithmetic problems—all from the Stanford-Binet—plus the Knox cube.

The final test described is by Stearns (**45**), whose system of selection on essentially psychological grounds is particularly worthy of attention. In three papers in 1918 Stearns reported his experiences in the psychiatric examination of recruits. In one paper (**42**) he cites a number of brief cases illustrating the value of his history method; in another (**43**) he gives data from 2000 examinations. In this paper he says: "Psychologic methods were considered and rejected for two reasons: First, they are too cumbersome. Second, the application of the findings is not specific enough, and applies largely to the feebleminded group." In spite of this statement he reported in 1919 (**44**) his method of classifying recruits. This method is described at greater length in his 1924 paper, although there are more detailed data in the earlier one. The method utilizes four areas: physical fitness, mental capacity and health, formal education, and industrial training. The final ratings do not include the first of these because the Navy Regulations do not recognize any condition of partial physical fitness. The other three are given scores between 1 and 4 on a specifically described basis; in addition, a list of 53 trades or occupations of significance in the Navy are numbered. The rating for a man might read 444.4, which would indicate a man of superior intelligence, college educa-

tion, professional occupation, and specifically a lawyer. Another might be 434.38, which would indicate a man of superior intelligence, high school education, having a skilled trade, a photographer.

The mental test upon which the rating for intelligence was based included: the Trabue Scale C (sentence completion), dissected sentences from the Binet, cancellation of "e" from a prose passage, memory span for digits (5, 6, 7, and 8 digits given), and the Healy code. The scoring was on a point basis with a maximum of 100. The distribution curve for 4000 cases (**44**) is decidedly asymmetrical, with an excessive number of cases having scores between 65 and 95. Wickes (**55**) gave this test with the exception of the code to 3020 recruits at the Newport Training Station between March and November, 1924. He reports the same skewed distribution of scores as was found by Stearns. Further, he points out as sources of error the disturbance on first arrival at the Station, inaptitude of examiners, cribbing, and the effect of poor performance on the cancellation test. An anonymous writer (**2**) reported the administration of the test to 731 midshipmen in the fourth-year class at the Naval Academy during the year 1922–1923. There was a progressive increase in the percentage of academic failures during the first year with decrease in score.

It is to be noted that all of the tests mentioned (except those by Goddard) were devised by Naval Medical Officers. All of the tests were serviceable for the specific function of eliminating the mentally subnormal. It is to be regretted that the authors did not present more adequate data. The dependence of all these efforts upon the Binet tests is indicated by the fact that of the 36 different items used exactly one-half were from the Binet, and of the 56 items including duplicates 33 were from the Binet series. All of these tests except that of Poppen (**29**) and that of the anonymous writer (**1**) were utilized during the activity of World War I. Since the paper of Stearns in 1924 there have been no further descriptions of intelligence tests in the *Naval Medical Bulletin*, although very recently Bell (**4**), writing on recruit selection, intimates that observation of the man's adjustment to his environment is of greater importance than his performance on psychological tests. It is interesting also to note that these descriptions of tests were all essentially independent of each other; reference to earlier descriptions is the exception rather than the rule. In no place is there any indication that any method was used in a general way in the Service.

One indirect method proposed for measuring intelligence should be noted. Hunt (**21**) felt that there might be a differential in performance time on the Jennings self-recording color test related to intelligence. He tested this hypothesis on 500 recruits and an unspecified number of children and institutionalized feeble-minded

who were classified into several ability groups by means of the Stearns test. While there was some indication that a higher percentage of superior subjects took less than 85 seconds on the color test, the differences were not great enough to prove meaningful, and so the method was abandoned.

Further discussion of the use of psychological tests in recruit selection is to be found in the annual reports of the Bureau of Navigation (**53**) from 1923 to 1930 and in the Secretary of the Navy's annual reports (**54**) from 1931 to 1933. That for 1923 reports that a Training Division had been established in the Bureau of Navigation on March 1, 1923, and that "steps are now being taken to provide tests for use in selecting candidates for the various schools in order that unsuitable personnel may be eliminated" (p. 221). The 1924 report indicates that the Division had been experimenting with tests, that a general classification test had been evolved, and that it had demonstrated its usefulness in selecting men for schools. In 1925 there is a somewhat more extensive discussion of these tests with data from a special study of 1000 men who had been in service about one year. Of these, 218 had been separated from the service (desertion, bad conduct, undesirable, medical survey, etc.) within the year, and their average score was 52.7; 445 had not been advanced from seaman second class, and their average score was 54.4; while the 337 men who had advanced at least to seaman first class had an average score of 68.3. Further, it was shown that advancement was secured by 42% of men having scores over 50, but by only 17% of those with scores lower than 50. The 1926 report refers to a study of 948 men examined at one station which found that the use of the test reduced the percentage dropped for inaptitude from 20% to 1% (see Jones, **23**). Brief reference is made to the tests in the annual reports for 1927 to 1929, and in the later year for the first time the report of the Recruiting Division mentions the higher quality of men being recruited as shown by the test results.

The indications are that this general classification test had been given at Training Stations after the men had been recruited. Apparently a change was instituted about 1931, and the test was given at Recruiting Stations. This can be deduced from the data shown in Table I, which has been compiled from material in the

TABLE I

GENERAL CLASSIFICATION TEST SCORES OF RECRUITS

Year	Per Cent of Scores		Year	Per Cent of Scores	
	Below 50	Above 50		Below 50	Above 50
1926	28.4	71.6	1930	17.3	82.7
1927	27.6	72.4	1931	5.1	94.9
1928	22.3	77.7	1932	2.8	97.2
1929	19.2	80.8	1933	0.7	99.3

1930 annual report (up to 1930) and the Secretary's reports from 1931 to 1933. The very sudden drop in the percentage below 50 evident in 1931 would indicate that a minimum had been established and that men were eliminated at the Recruiting Stations. The Secretary of the Navy's annual report for 1931 to 1933 gives the average scores of recruits for these years as 78.3, 77.7, and 81.8, respectively. It is interesting to note that this last average score is equivalent to an Otis IQ of 103.

While the discussions in the annual reports chiefly refer to the general classification test, there are indications that similar work was being done with educational and trade aptitude tests. It is therefore amazing to read an article by Lincoln (**24**) in which, in

TABLE II

GENERAL CLASSIFICATION TEST SCORES OF PETTY OFFICERS

	Number	Average
Seaman (boatswain, gunner, quartermaster, etc.)	128	68.3 (66.0)
Artificer (deck) (electrician, radio, carpenter, etc.)	94	78.4 (66.1)
Artificer (engine) (machinists, watertender, smiths, etc.)	199	62.8
Special (yeomen, storekeepers, pharmacists)	35	80.0
Commissary (ship cook, baker)	25	45.6 (49.6)

apparent ignorance of everything that was being done, he suggests the great value of aptitude testing for recruit selection and proposes that the O'Conner tests be used. These, he says, would require only about two hours examining for each man!

Rowcliff (**33**) reports a study of the scores on the G.C.T. made by men at a Training Station who were selected for trade schools. These show that while the average for all men was 65.5, the average for the various trade groups ranged from 71.6 to 83.5 except for small groups of musicians and buglers, who had averages of 67.6 and 50.9, respectively. The author calls attention to the fact that with such selection there is "the consequent lower standard of intelligence of the remainder which goes aboard ship to become available for all other ratings." Rowcliff also examined 481 petty officers aboard three ships and presents the average scores for various ratings. The average scores for five large branches of the service are given in Table II. Apparently the averages published by the author are in error or at least do not agree with averages calculated from his published data. The author's published averages are given in parentheses where they differ from the recalculations.

Officer Personnel

I have been able to find only two references, in addition to the anonymous note (2) mentioned above, which are concerned with the psychological examining of officer personnel. Craven (11), discussing the "selection-up" and "selection-out" of officers, proposes that, while psychological tests should not be used for admission to Annapolis, there should be a carefully arranged series of tests used during the course of the entire four years. Similar tests should be given to junior officers, and furthermore the officers' fitness reports should be changed under the direction of a psychologist. Craven does not offer any specific suggestions as to the types of tests to be used.

Rooks (32), in describing the entrance procedures for the Naval Academy, says that careful study had been made of the usefulness of psychological tests at the Academy, and it had been decided they were impracticable because (1) they do not measure "innate intelligence," (2) the chief claim that can be made is that of economy and simplicity, (3) their predictive efficiency is not large and not superior to the entrance examinations in use. Data are given for classes of 1930 to 1933, and it is shown that consistent use of the Otis S.A. test would have eliminated only 27% of the 416 men who failed.

Aviators

The earliest paper reporting the use of psychological methods in the selection of naval aviators which I have found is by Bachman (3). While devoted primarily to the physical examination, there are a few pages devoted to psychological tests. The methods used included reaction time (details not given), judgment of length of rods, of speed of revolving discs, and of time of sand running in a glass, and a simple jigsaw type of formboard. The author says his crude tests showed some value, but they need refinement.

In the same year Parsons (28) particularly criticized the dependence upon physical condition in the selection of aviators and emphasized the necessity of considering such psychological factors as intelligence, emotional control, dependability, persistence, etc. He asked the judgment of aviators as to the characteristics desired in airplane pilots and secured unanimous agreement on intelligence, good muscular coördination, keen equilibrium sense, and good judgment of velocity and distance; general agreement was found for temperamental stability and physical strength. On the

basis of these findings and with the advice of L. E. Troland and H. E. Burtt he developed a battery of tests as follows: (1) coolness: rapid addition with a record of pulse and respiration, interrupted by a sudden stimulus; (2) alertness: reaction time to visual, auditory, and tactual stimuli; (3) muscle coördination: execution of described movements rapidly; (4) mental alertness: time required to read words with reversed spelling; (5) judgment of distance using a moving object; (6) observation and report; (7) fear of flying using word association; (8) equilibrium reaction time to tilting; (9) ergographic tracing; (10) intelligence test, using the "Troland-Pressey machine." Rather extensive data on 74 subjects are given for all tests except 5, 8, 9, and 10. Of the remaining six tests the first and seventh made adequate differential selection of good and poor aviators; the others he advises abandoning.

Rhoades (**31**) discusses the importance of determining personality characteristics in selection and describes a history interview method. He mentions specifically the use of reaction time measurements in word association and by means of the domino test.

Sutton (**47**) and DeFoney (**12**, **13**) report at some length under the title "Psychology in aviation" on a method of examining for personality characteristics by means of a personal interview technique. The specific details of the method are not presented in any of these papers, but Sutton describes it as involving the securing of family and personal history in a one-hour interview. The examiner rates the responses on a four-point scale. The final score is based upon ratings for intelligence, responsibility, reaction time, judgment, stability, memory, and attention. The method is essentially clinical in nature and rests upon the examiner's subjective insight. For example, Sutton says that the subject is trying to make the best impression possible; therefore he may try to give what he believes are the most acceptable answers. In so doing there may be obviously lengthened reaction times in answering, especially if the man's responses are not strictly accurate. Such hesitance is considered in making the ratings.

DeFoney, in his two papers, presents validating data for the method. The first paper reports data on examinations and later flight training history for 628 men, and the second on 677 additional men. The findings of the two reports are in essential agreement. The data presented are extensive, and we can give only the final summary. From the total group of 1305 men 479 were selected by the test as good material. Of these, 77.6% qualified and

22.4% failed to qualify. Of the 826 men who were judged poor material by test, only 32.5% qualified, and of these an appreciable number required additional training hours in order to qualify. It is also important to learn that the good material had a crash rate of 0.2, while that of the poor material who qualified had a rate three times as great, viz., 0.65.

Miscellaneous

Raymond Dodge (14, 15), working with the Navy, devised selection and training methods for "gun-pointing, fire-control plotting, anti-submarine listening, and the lookout service" (14). None of these are described in detail, but the gun-pointing problem involved measurement of visual perceptual time and accuracy, and motor control. The tests for fire-control plotting included "the ability to repeat clearly by telephone, a series of ordinary commands that were received by telephone, the ability to remember and repeat numerals, to read a circular scale, to read a plotting scale and to lay off distances to scale, together with neatness and accuracy in drawing and sub-dividing simple geometrical figures" (15).

Galbraith (17) describes a test for selecting enlisted personnel for a listener's school which may be similar, if not identical, to that devised, but not described, by Dodge. Galbraith's battery included: memory span, reading degrees from a circular scale, localization of a concealed sound, discrimination of familiar sounds, and plane localization of binocular sounds.

Jones (23) presents results on the use of the "O'Rourke Intelligence Test" in the selection of submarine personnel. A critical score of 45 was determined, and the use of the test reduced dismissals for inaptitude from 20 to 1%.

Summary

This paper represents merely an historical account of psychological examining that has been carried on in the Naval Service. It has significance for psychologists because most of these reports have been entirely missed by psychological bibliographers. Perhaps the most surprising findings from this survey are the relatively large number of reports and the almost complete lack of coördination among the several authors.

BIBLIOGRAPHY

1. ANON. (Letter describing tests for recruits.) *Nav. med. Bull., Wash.*, 1922, **16**, 1111–1114.
2. ANON. The value of psychometric tests in the Navy. *Nav. med. Bull., Wash.*, 1924, **20**, 213–214.
3. BACHMAN, R. A. The examination of aviators. *Nav. med. Bull., Wash.*, 1918, **12**, 30–41.
4. BELL, R. A. Recruit selection. *Nav. med. Bull., Wash.*, 1940, **38**, 301–306.
5. BIEG, V. N. Naval men and their management. *Nav. Inst. Proc.*, 1915, **41**, 1173–1183.
6. BISCH, L. E. A routine method of mental examinations for naval recruits. *Nav. med. Bull., Wash.*, 1919, **13**, 198–228.
7. BOSTICK, J. B. Notes on recruiting. *Nav. med. Bull., Wash.*, 1915, **9**, 340–341.
8. BUTTS, H. The mental examination of candidates for enlistment in the Navy and Marine Corps. *Nav. med. Bull., Wash.*, 1911, **5**, 29–38.
9. BUTTS, H. The mental examination of fifty recruits who became insane soon after enlistment. *Nav. med. Bull., Wash.*, 1911, **5**, 295–312.
10. COTTLE, J. F. The turnover of personnel. *Nav. Inst. Proc.*, 1919, **45**, 379–382.
11. CRAVEN, F. S. Promotion and natural selection. *Nav. Inst. Proc.*, 1919, **45**, 1959–1970.
12. DEFONEY, C. G. Psychological study made on candidates for aviation training. *Nav. med. Bull., Wash.*, 1931, **29**, 191–204.
13. DEFONEY, C. G. A second psychological study made on candidates for aviation training. *Nav. med. Bull., Wash.*, 1933, **31**, 103–111.
14. DODGE, R. Mental engineering. *Amer. Rev. Rev.*, 1919, **59**, 504–508.
15. DODGE, R. (Report of his work as Lieutenant Commander, U.S.N.R.F.) (Included in Yerkes, **56**.)
16. DURR, E. The training of recruits. *Nav. Inst. Proc.*, 1917, **43**, 99–123.
17. GALBRAITH, F. B. Observations on 200 men examined for candidates for the listener's school. *Nav. med. Bull., Wash.*, 1919, **13**, 380–390.
18. GODDARD, H. H. The place of intelligence in modern warfare. *Nav. med. Bull., Wash.*, 1917, **11**, 283–289.
19. HENNING, E. R. Rebuilding the Navy's enlisted personnel. *Nav. Inst. Proc.*, 1920, **46**, 1979–1985.
20. HILDRETH, G. H. A bibliography of mental tests and rating scales. (2nd ed.) New York: Psychological Corporation, 1939.
21. HUNT, R. H. The color test not reliable as a mental test. *Nav. med. Bull., Wash.*, 1924, **21**, 74–76.
22. JENKINS, H. E. Mental defectives at Naval Disciplinary Barracks, Port Royal, S. C. *Nav. med. Bull., Wash.*, 1915, **9**, 211–221.
23. JONES, R. F. Selection of personnel for submarines. *Nav. med. Bull., Wash.*, 1926, **24**, 461–476.
24. LINCOLN, P. S. Human engineering and the Navy. *Nav. Inst. Proc.*, 1936, **62**, 352–356.
25. LOWNDES, C. H. T. Recruiting in the Navy. *Milit. Surg.*, 1912, **30**, 560–564.
26. MCDANIEL, F. L. Report of the psychiatric division on recruits entering incoming detention camps. *Nav. med. Bull., Wash.*, 1919, **13**, 854–858.

27. McMULLIN, J. J. A. Some observations on the examinations of recruits. *Nav. med. Bull., Wash.*, 1915, **9**, 70–74.
28. PARSONS, R. P. A search for nonphysical standards for naval aviators. *Nav. med. Bull., Wash.*, 1918, **12**, 155–172.
29. POPPEN, J. R. Psychometric tests for recruiting stations. *Nav. med. Bull., Wash.*, 1923, **18**, 14–25.
30. RATCLIFF, T. A. Constitutional inferiority in the Navy. *Nav. med. Bull., Wash.*, 1919, **13**, 728–733.
31. RHOADES, G. C. Examination of candidates for aviation training. *Nav. med. Bull., Wash.*, 1928, **26**, 502–514.
32. ROOKS, A. H. Entrance requirements of the U. S. Naval Academy. *Nav. Inst. Proc.*, 1935, **61**, 1468–1481.
33. ROWCLIFF, G. J. Petty officers. *Nav. Inst. Proc.*, 1932, **58**, 1253–1263.
34. SCHIER, A. R. The detection of the feebleminded applicant for enlistment—value of the Binet-Simon scale as a diagnostic aid. *Nav. med. Bull., Wash.*, 1913, **7**, 345–360.
35. SCHIER, A. R. The feebleminded from a military standpoint. Suggested examination for their early detection. *Nav. med. Bull., Wash.*, 1914, **8**, 247–258.
36. SCHIER, A. R. Review and possibilities of mental tests in the examination of applicants for enlistment. *Nav. med. Bull., Wash.*, 1915, **9**, 222–226.
37. SCHIER, A. R. A further study of mental tests in the examination of recruits. *Nav. med. Bull., Wash.*, 1917, **11**, 325–333.
38. SHEEHAN, R. Service use of intelligence tests. *Nav. med. Bull., Wash.*, 1915, **9**, 194–200.
39. SHEEHAN, R. Exclusion of the mentally unfit from the military service. *Nav. med. Bull., Wash.*, 1916, **10**, 213–249.
40. SHEEHAN, R. Military use of intelligence tests. *Milit. Surg.*, 1922, **50**, 423–428.
41. STEARNS, A. W. The importance of a history as a means of detecting psychopathic recruits. *Milit. Surg.*, 1918, **43**, 652–661.
42. STEARNS, A. W. The history as a means of detecting the undesirable candidates for enlistment with special reference to military delinquent. *Nav. med. Bull., Wash.*, 1918, **12**, 413–418.
43. STEARNS, A. W. The psychiatric examination of recruits. *J. Amer. med. Ass.*, 1918, **70**, 229–231.
44. STEARNS, A. W. The classification of naval recruits. *Calif. St. J. Med.*, 1919, **17**, 110.
45. STEARNS, A. W. The detection of the psychopath and the classification of naval recruits in accordance with their intelligence. *Nav. med. Bull., Wash.*, 1924, **20**, 149–169.
46. STOKES, C. F. Editorial (on mental preparedness in the Navy). *Nav. med. Bull., Wash.*, 1913, **7**, 417–419.
47. SUTTON, D. G. Psychology in aviation. *Nav. med. Bull., Wash.*, 1930, **28**, 5–13.
48. TAUSSIG, J. K. The enlisted personnel of the Navy. *Nav. Inst. Proc.*, 1915, **41**, 1781–1831.
49. THOM, J. C. Rebuilding the Navy's enlisted personnel and reestablishing its morale and spirit. *Nav. Inst. Proc.*, 1920, **46**, 1627–1636.

50. THOMAS, G. E. The value of the mental test and its value to the Service. *Nav. med. Bull., Wash.*, 1915, **9**, 200–211.
51. THOMAS, G. E. Second report on the Schier test for mentality, with special reference to the point system. *Nav. med. Bull., Wash.*, 1916, **10**, 68–70.
52. THORPE, G. C. Psychology of naval personnel. *Nav. Inst. Proc.*, 1916, **42**, 1–21.
53. U. S. NAVY DEPARTMENT. Annual reports, 1923 to 1930.
54. U. S. SECRETARY OF THE NAVY. Annual reports, 1931 to 1933.
55. WICKES, G. L. Mental tests at the United States Naval Training Station, Newport, R. I. *Nav. med. Bull., Wash.*, 1925, **22**, 664–672.
56. YERKES, R. M. Report of the Psychology Committee of the National Research Council. *Psychol. Rev.*, 1919, **26**, 83–149.
57. YERKES, R. M. Psychological examining in the United States Army. *Nat. Acad. Sci. Mem.*, 1921, No. 15.

PSYCHOLOGY IN WESTERN HIGH SCHOOLS

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Several studies have been made of psychology in secondary schools; these are listed, so far as we could discover them, at the end of this paper.[2]

Our first inquiry was addressed to the superintendents of schools in cities of 10,000 or more (some smaller cities in sparsely populated states) in 22 Western and Midwestern states. No attempt was made to compare regions. Even within this one area our data are incomplete; we found a course in one or more public high schools in more than a fifth of the cities canvassed, but we do not know how many more there may be. Our primary purpose was to obtain information about the course itself.

TABLE I

States	No. of Cities Addressed	No. of Superintendents' Replies	No. of Schools Found	No. of Schools Replying	No. of Teachers Reporting
	Total 247	Total 136	Total 70	Total 61	Total 70
Arizona	6	2	0	—	—
California[3]	—	—	8	8	9
Colorado	7	2	0	—	—
Idaho	5	3	1	1	2
Illinois	25	9	2	2	2
Indiana	16	8	2	2	2
Iowa	16	9	6	4	4
Kansas	23	15	11	7	7
Michigan	18	11	2	2	2
Minnesota	10	6	0	—	—
Missouri	11	5	11[4]	9	13
Montana	4	4	0	—	—
Nebraska	11	6	2	2	2
Nevada	2	1	0	—	—
New Mexico	7	4	1	1	1
North Dakota	5	2	1	1	1
Ohio	33	17	9	8	9
Oregon	5	4	0	—	—
South Dakota	5	3	1	1	1
Utah	5	5	6	6	6
Washington	11	7	3	3	3
Wisconsin	18	11	3	3	5
Wyoming	4	2	1	1	1

As shown in Table I, the preliminary inquiry was sent to 247 superintendents, of whom 41 said that psychology was offered in their schools, 95 said it was not, and 111 did not reply.[5] From the 41 positive replies and from other sources, 70 schools were found which were offering a course in psychology in the Spring of 1940. Their location, by states, is shown in the third column of Table I.

A questionnaire was then sent to teachers in these 70 schools, and replies were obtained from 70 individuals representing 61 schools. Not all questions were answered by all teachers or for all schools, but the omissions were few and do not cloud the picture significantly. What follows is an attempt to summarize the information given by these 70 teachers of psychology.

The Schools and the Course

The schools range in enrollment from 150 to 3600; mean and median, both 1200. There is usually only 1 teacher of psychology, but seven schools have 2, one has 3, and two have 4. The number of classes per teacher per annum is usually 2, but in six instances it is from 7 up to 10. The total number of pupils taught per teacher per annum ranges from 20 to 420; median, 85. In only four instances does the course continue for more than one semester. In two-thirds of the schools it is a twelfth-grade (senior) course; in the remainder it may begin in the eleventh year, but not sooner. Credit is given in every case but one. As a rule it is elective, but is required in two schools. In some of the schools psychology has long been a part of the curriculum: in one school, 48 years; in one, 29; in eight, from 20 to 25; median, 10 years.

In response to the question, "What is the appeal of psychology to students? much, little, none," there are 2 failures to answer, 5 qualified answers, 2 answer "little," and the remaining 61 check "much." In this connection it may be noted that among the 95 superintendents whose systems do not offer psychology 13 reply

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[1] The late Lloyd Berg, of Idaho, initiated this study and collected the data while a graduate student at Berkeley. Warner Brown is responsible for the form of the present article.

[2] We are indebted to Professor C. P. Stone, who gave us access to some of this material.

[3] Questionnaires were not sent to California superintendents because the information was available in the *California School Directory, 1939–1940.*

[4] Nine in Kansas City.

[5] We wish to acknowledge the generous coöperation shown by the school officials and the teachers who replied to our inquiries.

to the question, "Is there a need or demand for such a course?" with a categorical "yes," while 19 others are doubtful or think there is a need but not a demand.

The Teachers

A Master's degree is held by 51 (73%) of the teachers; Bachelor's only, 16; Ph.D., 2; answer unintelligible, 1. College majors were: psychology, 18; education, 19; social sciences, 21; English, 8; science, 8; all others, 7. All but one of the 70 teachers answered about college work in psychology: 10 had had 10 or less semester units; 26, from 11 to 20; making a total of 37 (over half) who had taken 20 or less units. The median and mode are both close to 15 semester hours. The range of teaching experience is from 2 to 42 years; the median is 18; the average, half a year less. Some 12% teach no other subject; 39%, one other; 27%, two others; 22%, three others. The commonest combinations are with history (13), English (10), and economics (9). The combinations with some social science (40) are more than twice as frequent as those with a science (including mathematics). More than two-thirds of the teachers are men. Only one is affiliated with the American Psychological Association, but two others have been in the past.

Textbooks

Six teachers use no textbook. The remaining 64 mention 21 texts, and, as some of them use more than one book, there are 76

TABLE II

Textbooks

	S	P	U	Total
Robinson	5	20	3	28[6]
Ruch	5	5		10
Uhl & Powers	1	4		5
Morgan & Gilliland	6	1		7
Wheatley & Mallory	2	1		3
Morgan (*Sound mind*)	3			3
Bennett	1	2		3
14 Miscellaneous	2	8	7	17
	13	49	14	76

entries distributed into "entirely satisfactory" (S), "partly satisfactory" (P), and "unsatisfactory" (U), as shown in Table II.

[6] Eleven of these 28 are from Kansas City.

Among the 14 books included under "miscellaneous" no one is mentioned by more than two teachers.

Methods

All but two of the respondents use supplementary reading material, and all but four say "Yes," they "color the material with other facts" (from sociology, economics, etc.). All the teachers use class discussions; 77% lecture; 74% use "experiments"; 40%, "case studies"; 50%, "projects."

Content of the Course

A check list was provided which contained 31 names of topics. The ones most frequently checked as "among the 5 most emphasized" are:

Personality (development, improvement)	44
Feeling and emotion	30
Social behavior (culture, social activities)	25
Motivation (drive, desires, and goals)	24
Habit	24
Mental hygiene	23
How to study	21

Some topics—"criminality and delinquency," "abnormal psychology (feeble-mindedness, mental disorder)," and "imagination"—are emphasized by no more than one of these teachers.

Summary

A high school course in "psychology" is offered in more than one-fifth of the Western and Midwestern cities canvassed. The course is nothing new; it may have been in existence for a decade. The school is likely to be a large one. The course is for a single semester, usually in the last year. It is elective and credit is given for it. A textbook is used with which the teacher is not entirely satisfied. There are discussions, lectures, outside reading, "experiments," and often "projects" and "case-studies." The major emphasis is on personal and social adjustments, motives, and emotion. The teacher is more often a man than a woman, is likely to be a veteran of 15 or more years teaching experience and to have a Master's degree. He has probably had four or five courses in psychology in college. He specialized in psychology or education or a social science, rarely in science. His one psychology course each semester is not his main job; he teaches English or one of the social

sciences—less frequently, a science; nevertheless, in six cases out of seven he thinks the psychology course has "much appeal."

BIBLIOGRAPHY

1. Bjork, R. Psychology in the high schools of Montana. *Montana Educ.*, 1937, **13**, 10–11.
2. Broxson, J. A. The determination of a course in psychology for the high school. Unpublished Doctor's Thesis, Univ. Cincinnati, 1932.
3. Davis, H. C. A survey of the psychology courses offered in American junior colleges. Unpublished Master's Thesis, Stanford Univ., 1939.
4. Dent, E. L. A survey of high school psychology in Ohio. Unpublished Master's Thesis, Univ. Akron, 1938.
5. Gates, A. I., Stone, C. P., & Watson, G. B. The teaching of psychology in teachers colleges. *Psychol. Bull.*, 1938, **35**, 599–609.
6. Harris, R. S. Psychology in the high school. *Sch. & Community*, 1939, **25**, 62–63.
7. Pechstein, L. A., & Broxson, J. A. The determination of a course in psychology for the high school. *Sch. Rev.*, 1933, **41**, 356–361.
8. Pitkin, R. S. Psychology for high school students? *Progr. Educ.*, 1935, **12**, 251–253.
9. Riddle, E. M. Psychology by request. *High Sch. J.*, 1939, **22**, 275–277.
10. Stone, C. P., & Watson, G. Report of the committee to study problems connected with the teaching of psychology in high schools and junior colleges. *Psychol. Bull.*, 1936, **33**, 709–714.
11. Stone, C. P., & Watson, G. Committee to study problems connected with the teaching of psychology. Report A—Survey on the teaching of psychology in secondary schools and junior colleges. *Psychol. Bull.*, 1937, **34**, 660–662.

PREDICTING THE CHILD'S DEVELOPMENT

I

DEARBORN, W. F., & ROTHNEY, J. W. M. Predicting the child's development. Cambridge: Sci-Art, 1941. Pp. 360.

Those interested in forecasting the mental or physical growth individual children will find *Predicting the child's development* disappointing. They will approach the book expecting it to furnish them with media for dealing with such questions as it was announced to answer: "How tall will this lad of 5 be at the age of 14?" "When will this little girl experience the first signs of womanhood?" The first chapter will sustain their anticipation of predictive devices, though they will become uncertain regarding both the age intervals over which prediction is possible and the frequency with which reasonably accurate predictions can be made. According to this chapter, (a) for a few children as young as 9 or 10 years, there is a possibility of "prediction of the age at which sexual maturity will likely be attained" (p. 41); (b) "while a paralleling or railroad tracking" of individual stature curves for the years 7 to 18 "is the rule, there is some 'crossing of the tracks' " (p. 42); and (c) for curves of mental growth, "consistency is here again the rule," though "clear-cut crossings of the growth curves" occur and " 'constancy' of physical size is undoubtedly much greater than the constancy of the I.Q." (pp. 43; 48–49). The chapters which follow will progressively shatter their expectation of becoming acquainted with procedures for forecasting development. Findings are presented from varied analyses of child development data which indicate, and successively reiterate, "the hazard of prediction" (p. 232). In Chapter IV, the authors state: "Our findings and experience with the individual growth data do not seem to offer much promise of reliable prediction in the individual case" (p. 232). In their "Summary and Conclusions" the following statements are made: "We have established the fact that variability rather than consistency in growth is the rule . . ." (p. 346). "Physical and mental growth are essentially individual affairs" (p. 341). "Prediction of growth at various ages is extremely hazardous, . . . particularly so during the period of adolescence" (p. 342). (To the reviewer, it is incongruous, though unequivocal, that the book begins on the note "consistency" in physical and mental growth "is the rule," and closes on the note "variability rather than consistency in growth is the rule.")

The content of *Predicting the child's development* is based upon "an investigation of mental and physical growth which has come to be known as the Harvard Growth Study" (p. 58). The Study was inaugurated by Professor Walter F. Dearborn, the senior author, and carried on under his direction through "the Psycho-Educational Clinic of the Harvard Graduate School of Education" (p. 34). Collection of data began "in the fall of 1922," when approximately 3500 school children residing in "three cities of the metropolitan area of Boston were examined" (p. 34). "Most of the children were in the first grade and most were at ages 6, 7, and 8 years. The plan of the study required that these children be measured annually over a period of twelve years in respect to a number of characteristics," *e.g.* intelligence, educational achievement, body size, eruption of teeth, ossification of hand. Since the data were accumulated at a set series of schools, there was a gradual loss of subjects: "At age 10, one quarter of the original population were lost from the study,—at age 15, fifty per cent was lost, and at 17 three quarters . . . " (p. 71). Amassing of data was terminated in 1935, a total of approximately 200 graduate students in psychology and education having been "employed during the progress of the study" (p. 64). In this latter connection it is pertinent to mention that the Study had "two main objectives": "fact-finding" and "student training" (p. 66).

It will no doubt be confusing to many readers that the word "prediction" is used with other meanings than that of forecasting a child's status regarding some trait—or combination of traits—at a later age.

(1) It is used when referring to the relationship between traits at a given age. For example, a study on 233 sixteen-year-old boys is reported in which a multiple correlation coefficient of .25 was obtained, expressing the association between intelligence test performance and a combination of five body measurements. The authors state: "Prediction of test score on the basis of physical status would be successful in such a few cases that it would not be worth the effort" (p. 271). And again: "The relationship between the physical measurements and the mental measurements is so low that the knowledge of one does not enable us to predict the other" (p. 341). (2) It is used with reference to the "normal" or "satisfactory" body weight for a given child at a particular age. The authors report they have devised "a rather good equation for the prediction of normal weight for sixteen-year-old boys" (p. 305). The equation estimates body weight from a "weighted combination of chest depth, chest width, standing height and iliac" width (p. 303). Since the equation is interpreted as yielding "what an individual should weigh" (p. 309), "prediction" be-

comes synonymous with evaluation—with appraising an individual's weight status as satisfactory or unsatisfactory.

One of the major "practical outcomes inherent in the data and studies which comprise this volume" is stated as follows: " . . . it has been found that maximum growth ages present a practical means of classifying adolescents" (p. 57). This question arises: In what sense and for what purpose is it *practical* to classify adolescents according to age of greatest gain during the period 7 to 17 years of age? In the case of stature—the measurement suggested—occurrence of maximum gain varies from the tenth to the fourteenth year for girls and from the thirteenth to the seventeenth year for boys. At age 11 for girls and 14 for boys (one increment beyond the maximum being needed to indicate it has been attained), it would be possible to classify "adolescents" into (a) those few for whom the maximum is known to have been reached and (b) the remainder. Not until age 15 for girls and 18 for boys could the normal gamut of teen-age individuals all be assigned to "maximum growth age" categories. The "practical" value of classifying individuals 15 (girls) and 18 (boys) years of age in terms of a phenomenon which characterized them from one to six years earlier is neither made apparent nor specified.

On page 37 the authors state that maximum growth ages "coincide" with "the advent of the menarche in girls and of pubescence in boys. . . . " However, for girls, (a) the available research shows a systematic tendency, particularly marked in those with menarcheal ages later than average, for age of maximum acceleration to *precede* age of menarche,[1] and (b) considerable fluctuation in the timing of the two events is indicated by a statement found on page 145: "Ages at which individuals attain their maximum growth increments correlate .702 with menarcheal ages." For boys, the expressed relation between accelerated growth and "pubescence" appears not to be founded on any data for the latter. The authors state: "Shuttleworth has shown that the ages at which maximum growth occurs are . . . indicators of sexual maturity in boys . . . " (p. 40). Shuttleworth has not *shown* this; he has merely

[1] Cursory reading of the McGlinchey study reported on pages 162–168 may appear not to confirm this. However, careful examination will reveal that (a) McGlinchey utilized no cases with menarcheal ages later than 14.5 years, and that (b) her age of "highest peak" refers to the individual's stature rankings and frequently represents a later age than that of the "maximum growth spurt" with which it is erroneously identified.

suggested that it is "not a violent assumption to suppose that age at maximum growth is at least as good an indicator of the timing of significant endocrine events as age . . . of sexual maturity in boys . . . " (see *Monogr. Soc. Res. Child Develpm.*, 1939, **4**, No. 3, p. 2).

It is noted that (a) portions of the data accumulated by the Harvard Growth Study have been analyzed by numerous investigators; (b) "approximately 10 books and 70 articles based upon the data of the Study have been published" (p. 65); (c) "it would not be possible to do justice to the studies which have been made in a volume of this length . . . " (p. 238); (d) "it is our purpose . . . to report only the recent studies . . . in which the advantages of longitudinal data are best exhibited" (p. 239); (e) "we shall refer to them . . . as they relate to the particular" topics discussed (p. 238).

One topic treated is "Consistency in Growth of Stature." Here the authors incorporate a 20-page review of an unpublished study by Grace McGlinchey, the primary purpose of which "was to determine the constancy or fluctuation of the standing height of 266 subjects in relation to the mean of the group as a whole" (p. 150). The subjects were girls, mainly of North European and Italian descent. In summarizing her findings, it is stated: "The most arresting observation made was that no two of the 266 cases had identical standard scores at each age from 7 to 17. There were many cases which were closely parallel in development, but none were exactly the same throughout. . . . The conclusion appears to be that physical growth is essentially an individual affair" (pp. 161–162). The study is appropriately included. Inexplicable, however, is the exclusion of reference to other studies which have employed Harvard Growth Study data, made analyses only possible with seriatim records, and reported findings which definitely relate to constancy of growth in stature. These include: "The prediction of stature of North European males throughout the elementary school years" (*Hum. Biol.*, 1936, **8**, 279–283); "Individual trends for stature and anatomic age" (*Univ. Ia Stud. Child Welf.*, 1937, **12**, No. 5, Part 2); and "Stature of Massachusetts children of North European and Italian ancestry" (*Amer. J. phys. Anthrop.*, 1939, **24**, 301–346). The latter study, in particular, affords substantial findings for both females and males on "the form of individual stature curves" (pp. 319–326) and on "the stature rank of the individual at successive ages" (pp. 335–343).

There are numerous points at which more exact statement or greater specificity would minimize misinterpretation of the book's contents. To the examples already cited, the following may be briefly appended:

(1) On page 33 reference is made to an 1872 study by Bowditch: "Bowditch graphed the average measurements of the height of 12 males and 12 females made annually over a period of twenty-five years. He found evidence of growth increments up to that age." Actually, none of Bowditch's female subjects (13 rather than 12) were measured after 20 years of age, and none of his male subjects after 22 years.

(2) It is doubtful that the authors have evidence to support their statement: "Ordinarily accurate measurers may have periods when they repeatedly measure too high or too low" (p. 61). In its context, this statement appears to run counter to findings on the specific problem of anthropometric reliabilities and on the broader problem of the 'curve of error.'

(3) On page 84 it is stated: "During the first year, 18 anthropometrical measurements were made, but study of them revealed that some were not good indicators of development." The criteria against which such measurements as head girth and arm length were evaluated and found to be less adequate "indicators of development" than head width or chest depth are sufficiently pertinent to merit listing.

(4) In a paragraph headed "Critique of the Statistical Approach" one reads: "Statistical studies, in general, seldom contribute greatly to the understanding of the individual case. Why should one expect from studies of the growth *status* of different individuals to learn much about the growth *processes* going on within a single individual, or of the results of these processes?" (p. 276). It is not apparent why the authors regard statistical procedures as essentially applicable to cross-sectional data. Clearly, measures of central tendency and variability may be secured either for "status" data (*e.g.* weight values at a given age) or "process" data (values representing change in weight between two ages). Similarly, measures of relationship may be calculated either for status data (*e.g.* stature and hip width values at a given age) or for process data (values for stature on the same individuals at two ages). If the authors intended primarily to indicate that there were unsolved problems in the application of statistical procedures to longitudinal data, they neither made this evident nor provided the reader with an illustrative example.

HOWARD V. MEREDITH.

University of Iowa.

II

REPLY TO HOWARD V. MEREDITH'S REVIEW

BY WALTER F. DEARBORN
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The queries which are put in quotation marks in the opening sentences of the above review and which unfortunately seem to have determined the tenor of the whole critique are not to be found in the book, but in a prepublication announcement of the book. To give the publishers their due, and in contradiction of the reviewer's statement, it was not announced that these questions would be answered. At any rate, it would seem proper to confine a book review to what the book has to say. Further, it is to be noted that the title of the book is not a promise or even a wish fulfillment; it is a description of the chief *raison d'être* of this effort as of all methodological treatises.

If the reviewer is disappointed with the small accretions to the very limited existing means of prediction, his appetite must have been whetted beyond reason. One may be disappointed with the weather, but he has no right to take his disappointment out on the weather man. In a field in which great industry over a long period of years has produced so little (and in which the reviewer has, himself, toiled) it would seem reasonable to expect at least mention of some of the definite leads, if not accomplishments, in the direction of greater accuracy of prediction, which are to be found in the book. There is scarcely a word in the review as to the more constructive aspects of the study, such as, to cite a single example, providing the groundwork of a method for using the percentage of mental growth in terms of the estimated maximum growth of the individual, or of an unselected group, instead of the mental age and intelligence quotient technique. Such a measure may obviously have greater predictive value and greater reliability than the "I.Q." The word 'predictive' is used with different meanings, but they are obvious in their context. Interpretation of correlation coefficients in terms of forecasting efficiency is established usage.

As to the reviewer's second point of criticism, that the book begins on the note of consistency in physical and mental growth and closes on the note of variability, there is a close parallel in a recent and widely accepted general psychology which, after spending over 20 chapters in presenting what people have in common,

in the final section sets out to "emphasize differences" and concludes that every human being is unique and that "differences are the rule." It *is* partly a matter of interpretive emphasis; no hard and fast line can be drawn as to where consistency ends and variability begins. In contrast, and at the risk of seeming facetious, a recent poll (à la Gallup) of the occupants of the front-row seats at a musical comedy performance may be cited. Although there was evidence of attempts at preserving individuality and a count of the remaining hairs showed that no two heads had exactly the same number of hairs, the consensus of opinion was one of baldness.

In the present instance, although the introductory and the concluding chapters were written by two different persons, it was an inadvertency to have used the phrase "is the rule" for both consistency and variability, but there are no essential incongruities in the statements of findings throughout the book. The bald fact is consistency. The authors point out: (1) that physical growth is not as consistent as statements of certain authors of established reputation in the field have indicated, *e.g.* that "size at any age predicts size at all ages" and that "a reversal almost never happens" (p. 43); (2) that extensive samplings of individual cases show not infrequent crossings of the curves (p. 43); (3) that although in a sampling of 266 cases (p. 161) no two of the cases "had identical standard scores at each age from 7 to 17" and that thus, when every deviation is counted, physical growth appears "essentially an individual affair" (p. 162), yet when the sampling of cases is divided into six groups, "the fluctuation of each of these groups is orderly and consistent—there does not appear to be considerable group variation. On the contrary, the groups appear to be remarkable for the regularity of their fluctuations in the growth rhythm" (p. 153).

Similar findings are presented as to the constancy of mental growth as far as it can be estimated by intelligence tests. Over 40 individual growth curves are presented for the ages 8 to 16 to show how markedly variable the individual may be, yet the main finding remains that individuals "tend to remain throughout the period of their mental growth to age 16 in the same classification as they were at age 8."

The remaining points of criticism are either mildly misrepresentative, picayune, or both. The garbled quotation (excerpted with deletions from a paragraph on page 40 of the book)—to wit:

"Shuttleworth has shown that the ages at which maximum growth occurs are . . . indicators of sexual maturity in boys. . . ."—misrepresents the content of the passage. There are three statements in the paragraph which can be substantiated: (1) "Shuttleworth has shown that the ages at which maximum growth occurs are superior to menarcheal ages for the purpose of grouping together girls with similar growth patterns." (2) "He also presents evidence that they are as good, if not better, indicators of sexual maturity in boys than the various criteria, such as axillary hair, which have been previously employed." (3) "In view of the above findings and since now the same criteria may be used with boys and girls, it would appear that maximum growth ages (abbreviated as M. G. ages) provide a more practical and usable method for the classification of adolescent children than has hitherto been available."

On the very page of Shuttleworth's monograph from which the reviewer quotes (to prove that Shuttleworth has "*not shown* this," *i.e.* the garbled quotation), the following sentences are found in support of the above statements: (1) "For the purpose of grouping together girls with similar growth patterns these criterion ages are far superior to menarcheal ages." (2) "Further, our criterion ages are doubtless as good indicators of sexual maturity among boys as the criterion of axillary hair employed by Richey." (3) ". . . the criterion M. G.-ages, or ages at maximum growth, implied in this study are virtually universal in their application, they are highly reliable, and they provide a very excellent basis for the grouping of individuals with similar growth patterns. In addition they are good indicators of underlying endocrine events and of the attainment of sexual maturity. . . . Given the problem of describing patterns of physical growth during the second decade of life and given excellent indicators of the advent of sexual maturity, it is our considered judgment that classification of cases according to age at maximum growth is superior to classification according to age at sexual maturity." For the sake of brevity we will let these last citations also stand as an answer to the reviewer's query: "In what sense and for what purpose is it practical to classify adolescents . . . ?"

In reply to the criticism of the correlative study of McGlinchey, the following statements are made: (1) Since for 100 of the 266 cases selected at random for this study the date of menarche had been recorded, the growth data of these 100 girls were examined to note the relation between age of menarche and variations in

growth in height. In the absence of any evidence that a selective factor existed, the data used in the study were assumed to be a representative sample of the "population" involved. The objection, therefore, to the lack of cases whose menarcheal ages were later than 14.5 appears to be unjustified.

(2) It is to be noted that the growth curves are based upon the standard scores of the cases plotted in relation to the mean. Since this basic handling of the data has been explained, a description of the maximum fluctuations of these curves in relation to the mean as "highest peak" or "maximum growth spurt" should not have been misleading.

Reference to the reviewer's use of Harvard Growth Study materials is made in a footnote on page 238. The authors agree that a more extended notice of the reviewer's contributions would have been desirable.

As to the Bowditch report, the following statements are quoted from the proceedings of the Medical Society meeting at which Bowditch presented his "diagram": " . . . the measurements were all taken annually during the last twenty-five years," and " . . . growth went on, though slowly, to nearly twenty-five years of age." The reference was made, not so much for its factual value, as for its historical interest.

The requirement, as the Study progressed, of three independent measurements was made partly because of evidence that experienced examiners did measure at times "too high or too low."

The authors do not "regard statistical procedures as essentially applicable to cross-sectional data." For examples of their application to longitudinal data, see pp. 78, 110, 112, 146–149, 170, 201–202, 213–230, 232, 245, 288, and 300 of the text.

Finally, in the summary of the book a score or more of findings are listed which have been neither confirmed nor refuted by the reviewer. They are not discussed. If the reader wants to know what they are, he will either have to consult the book or find a more informative and constructive review. The fact that the substance of the book has escaped unscathed at the hands of so critical a reviewer is comforting to the authors and may be reassuring to the reader.

III

A NOTE ON PROFESSOR DEARBORN'S REPLY

BY HOWARD V. MEREDITH
University of Iowa

In reviewing publications in child development, it is my working assumption that critical statements should be confined to those areas in which the reviewer is best qualified to undertake rigorous examination and appraisement. My review of *Predicting the child's development* is focused upon the problem of reasonable clarity and accuracy in the reporting and interpretation of research on physical growth. It is intended to afford readers of the *Psychological Bulletin* one worker's careful and well-considered reactions. Interested readers will want to set aside certain of Professor Dearborn's phrases (*e.g.* "mildly misrepresentative," "picayune," "garbled quotation," "misrepresents the content," reviewer's "appetite must have been whetted beyond reason") and proceed to an examination of the materials and issues at their source.

PSYCHOLOGY AND THE WAR

STEUART HENDERSON BRITT, *Editor*

Employment of Psychologists in the Federal Government

The Federal government is the largest single employer of psychologists. This should be an important item of news to those psychologists over the country who may feel that psychologists are not being adequately utilized in the war effort. Not only are large numbers of psychologists engaged in psychological activities in connection with the military program, but most of the others working for the Federal government are concerned with problems very closely related to the war program.

More than 400 psychologists are today employed in various branches of the Federal service. As to the exact number, this depends on our definition of who is a psychologist. Included in this estimate of over 400 are individuals who are well trained and experienced in psychology and who are engaged essentially in psychological work (such names as Bingham, Brotemarkle, Carmichael, Jenkins, Likert, Louttit, Richardson, Shartle, and many others come to mind); those who are trained in psychology, but who are not engaged in purely psychological work; and those with only a small amount of graduate work in psychology, but who are carrying on psychological activities in their jobs.

Although large numbers of the psychologists employed in the Federal service are stationed in Washington, D. C., many others are located in other sections of the country. Of course, it should also be noted that a great many other individuals around the country who are not actually holding Federal positions are working on psychological research projects and carrying on other important endeavors in relation to national defense. The current survey indicates that psychologists are employed in those divisions of the Federal government listed below, although it may be that there are additional agencies which should be added to the list:

War Department

Air Forces:
  Office of the Air Surgeon
General Staff
Office of the Adjutant General:
  Field
  Personnel Procedures Section
Office of the Chief Signal Officer

Navy Department
- Bureau of Aeronautics
- Bureau of Medicine and Surgery
- Bureau of Navigation

Department of Commerce
- Bureau of the Census:
  - Division of Statistical Research
- Civil Aeronautics Administration
- National Bureau of Standards

Department of Agriculture
- Bureau of Agricultural Economics
- Bureau of Home Economics
- Farm Credit Administration
- Forest Service
- Office of Personnel
- Surplus Marketing Administration

Department of Justice
- Bureau of Prisons

Department of Labor
- Bureau of Labor Statistics
- Children's Bureau

United States Civil Service Commission
- Council of Personnel Administration
- Director of Research
- Examining Division

Federal Works Agency
- Public Works Administration
- United States Housing Authority
- Works Progress Administration

Federal Security Agency
- Civilian Conservation Corps
- Howard University
- National Youth Administration
- Office of Education
- St. Elizabeths Hospital
- Social Security Board:
  - Bureau of Employment Security
  - Bureau of Research and Statistics
  - State Technical Advisory Service
- United States Public Health Service:
  - Division of Industrial Hygiene
  - National Institute of Health

Federal Communications Commission
- Foreign Broadcast Monitoring Service

Coordinator of Information
Office of Facts and Figures
Office of Coordinator of Inter-American Affairs
Tennessee Valley Authority
Library of Congress
National Advisory Committee for Aeronautics
National Roster of Scientific and Specialized Personnel

The best procedure for any psychologist interested in government service is to write to the Information and Recruiting Section of the United States Civil Service Commission and ask to have his name put on a list to receive notices of examinations in such fields as psychology, personnel work, and statistics. Information concerning examinations in all fields covered by the Civil Service Commission can also be obtained at any first- or second-class post office. Also, any psychologist who has not already registered with the National Roster of Scientific and Specialized Personnel, 916 "G" Street N.W., Washington, D. C., should write to the National Roster and ask to receive a check list in the field of psychology. Although the National Roster of Scientific and Specialized Personnel is not an employment agency, it does receive requests from other governmental agencies to supply names of individuals with various types of technical training, and thus the names of psychologists and other specialists may from time to time be presented to such agencies for consideration. However, the place to write with reference to individual problems of psychologists is not the National Roster of Scientific and Specialized Personnel, but rather the Office of Psychological Personnel, National Research Council, 2101 Constitution Avenue, Washington, D. C., which is discussed below.

The Office of Psychological Personnel, and The National Roster of Scientific and Specialized Personnel

Letters received from many psychologists throughout the country indicate the desirability at this time of a published statement regarding the functions of the Office of Psychological Personnel, National Research Council, and the National Roster of Scientific and Specialized Personnel. These are two separate organizations in Washington, D. C., situated in different parts of the city and

concerned with different problems. The two offices are located as follows:

(1) Office of Psychological Personnel
National Research Council
2101 Constitution Avenue
Washington, D. C.

(2) National Roster of Scientific and Specialized Personnel
916 "G" Street N.W.
Washington, D. C.

(1) The Office of Psychological Personnel, located in the building of the National Research Council, is an office newly created by the American Psychological Association in order to assist psychologists throughout the country on various personnel problems, such as information concerning the utilization of psychologists in the Federal government, the Army, the Navy, and in various research projects. It is not a governmental agency, but exists in order to serve as a "clearing house" of information for psychologists, and to perform other duties in Washington, D. C., for psychologists living in other sections of the country.

Just as soon as a man fills out and returns the questionnaires sent to him by the Office of Psychological Personnel (formerly called the Subcommittee on the Listing of Personnel in Psychology), information is immediately sent to the War Department concerning him. This means that rather complete information is then on file in the War Department about him even prior to his possible induction. Thus, if any inquiry arises within any branch of the War Department for the names of individual psychologists, the information is readily accessible. Also, prior to the induction of any psychologist, information about him can be sent from the appropriate division of the War Department to his Reception Center, indicating his specialized training and his probable date of induction. This is in no sense a guarantee that any individual psychologist necessarily will be utilized in psychological work, although it does mean that, if there is a need for men with his particular type of training, he might be used in classification or testing work.

(2) On the other hand, the National Roster of Scientific and Specialized Personnel is a governmental agency jointly administered by the National Resources Planning Board and the United States Civil Service Commission, and its primary function is the conservation and most effective utilization of scientifically and technically trained personnel in all fields in connection with the

national defense program. Over 50 different fields of specialization are represented in the National Roster of Scientific and Specialized Personnel, and psychology alone accounts for the registration of over 3,200 individuals. The National Roster from time to time fills personnel needs of other governmental agencies by supplying names and other information concerning specialists in various fields, but it is not an office dealing with individual problems of psychologists. Instead, matters of this sort should be taken up with the Office of Psychological Personnel at the National Research Council.

At present the National Roster of Scientific and Specialized Personnel is engaged in the collection of special information about persons registered with it whose age would make them subject to call for training and service under the provisions of the Selective Training and Service Act of 1940. Although the Roster has no direct authority with reference to classification or induction procedures under the Selective Service System, it is charged with the obligation of assisting the nation in using its trained personnel in the most effective way possible. Accordingly, under a cooperative plan the Roster, *in certain cases only*, will transmit to the Office of the National Headquarters of the Selective Service System in Washington, D. C., appropriate information about technically trained persons of military age, and that office in turn may send letters about these men to their Local Boards to assist in their proper classification. Of course, it should be understood that the matter of classification is within the jurisdiction of the Selective Service Local Boards.

Also, whenever a man registered with the National Roster is likely to be inducted into the Army, information is sent to the appropriate division of the War Department, giving his educational training, occupational experience, and other pertinent data. Obviously, no guarantee can be given in advance that this procedure will result in any special privilege, since there are occupational shortage problems in the Army as well as personality factors that must be taken into account. But the information sent to the War Department thus far about various men has been of very practical use in the procedure of assigning such technically trained individuals to their duties.

In other words, any man who is now engaged in, or has completed, any graduate work in psychology, and who is subject to call under Selective Service, should write at once, if he has not already done so, to *both* the Office of Psychological Personnel,

National Research Council, and to the National Roster of Scientific and Specialized Personnel, and ask to receive appropriate questionnaires in psychology. In both instances he should be sure to mention that he has had graduate training in psychology and that he is of military age. (If he has done no graduate work in psychology, but has simply majored in psychology in college, he should write *only* to the Office of Psychological Personnel, National Research Council.) He should also inform both offices *immediately* if his classification under Selective Service changes or if he is nearing induction, in order that detailed information about him can be sent to the War Department.

It should be clearly understood that neither the National Roster of Scientific and Specialized Personnel nor the Office of Psychological Personnel, National Research Council, can secure commissions in any branch of the service for anyone. A few psychologists with special qualifications have been commissioned in the Office of the Air Surgeon, Headquarters of the Army Air Forces, and have been assigned to duties in Psychological Research Sections, but any further policy with reference to the commissioning of men of military age cannot be stated. It should also be emphasized that no definite promises can be made by the two offices discussed above or by the War Department that any given individual will necessarily be used in psychological work, although the chances are very great that men with psychological training will be utilized either in classification, personnel, or testing work. In some instances this may lead to officer's training, but in other cases not. In those instances in which a psychologist is commissioned, he probably will serve as a Personnel Consultant; the psychologist who is not commissioned probably will assist in classification work or in some special testing program. Therefore, any man who enlists or is inducted should be sure to tell his interviewing officer at his Reception Center the details of his specialized training and experience.

There are two kinds of activities in particular which psychologists inducted into the Army are carrying on at the present time. One is the testing of aviation cadets, performed by psychologists attached to Office of the Air Surgeon, Headquarters of the Army Air Forces; the other is personnel and classification work in various arms and services. The former program was described in the March issue of the *Psychological Bulletin;* additional information concerning personnel work in the Army will be given in the May issue.

BOOK REVIEWS

HOLZINGER, K. J., & HARMAN, H. H. Factor analysis: a synthesis of factorial methods. Chicago: Univ. Chicago Press, 1941. Pp. xii + 417.

For a book on factor analysis the present volume is remarkably free from emotional bias or pet theories. This is in part due to the fact that the authors consider factor analysis as a statistical method generally applicable to all problems where a large number of quantitative variables are involved, rather than merely to the restricted fields of psychology and education which have been primarily responsible for the development of the factor methods. All of the leading factor techniques are given competent treatment with no attempts to disparage or champion any individual method. Very little of the controversial exposition which has characterized several of the preceding volumes on factor analysis by other writers is to be found in this volume.

The book is divided into four parts:

Part I, "Analytical and Geometric Bases for Factor Analysis," consists of five chapters: "Introduction"; "Basic Statistics"; "Geometric Formulation of the Factor Problem"; "Determination of the Common Factor Space"; and "Preferred Types of Orthogonal Solutions." In the first four of these chapters is developed the basic mathematical foundation for factor analysis common to all generally accepted methods. Chapter 5 introduces the various types of current factor methods.

Part II, "Direct Orthogonal Solutions," includes three chapters entitled, respectively, "The Bi-Factor Solution and Sampling Formulas"; "The Principal Factor Solution"; and "The Centroid Solution." For each method the basic formulas are developed in some detail, and many diagrams and numerical illustrations are provided.

Part III, "Derived Solutions—Orthogonal and Oblique," includes the following chapters: "Derived Principal Factor Solution"; "Orthogonal Transformations in the Multiple Factor Solution"; and "Oblique Solution." Diagrams and numerical examples are extensively used to clarify the mathematical exposition in these three chapters.

Part IV, "Estimation of Factors and Relationships Between Factors," includes two chapters: "The Estimation of Factors" and "Relationship Between Different Factor Solutions." The first of these is concerned with the problem of estimating factor loadings on each of the factors for each case in the sample, and a number of alternative methods are presented. The second chapter is concerned simply with methods for transforming one factor matrix into another. Here again extensive numerical examples are provided.

A lengthy appendix following the text includes, among other things, an outline of the fundamentals of matrix theory, outlines for computation of the various factor methods, and work-sheet procedures for the solution of simultaneous linear equations. A bibliography of more than 130 references is included in the volume.

It would, of course, be possible to suggest various other alternative procedures for carrying out the computations in connection with the methods of factor analysis described, but it is not to be expected that all

practical or useful variations could be included in a volume even so complete as this one. One omission, however, was a little surprising to the reviewer. The authors, in discussing the transformation of a given pattern to a principal factor solution, indicate the formal solution based on a characteristic equation. Numerical illustrations are given in considerable detail. The authors fail, however, to point out that the characteristic equation in this connection is entirely analogous to the one obtained in the direct principal axis solution and that the same iterative procedure which they suggest for the direct solution is applicable when transforming a given pattern to a principal factor solution. As a matter of fact, the formal solution is almost prohibitive if the number of factors is more than five or six.

Some contributors to the development of factor analysis methods will recognize solutions and procedures which the authors have not explicitly attributed to them, but in so rapidly expanding a field, it is not to be expected that such an ambitious synthesis as the authors have attempted can hope to allocate credit to the satisfaction of all.

Investigators who have struggled with an extensive variety of factor configurations will recognize the limitations of the technique of beta-coefficients in certain special cases and may well wish for a discussion of other possible alternative methods for the preliminary grouping of variables.

However, the authors have turned out a thoroughly professional job. Whatever may be said of the individual merits of previous volumes on factor analysis, the present volume is undoubtedly the most useful contribution as a general textbook and reference work which has yet appeared on the subject of factor analysis.

PAUL HORST.

The Procter & Gamble Company,
Cincinnati, Ohio.

RUCH, F. L. Psychology and life: a study of the thinking, feeling, and doing of people. (New ed.) Chicago: Scott, Foresman, 1941. Pp. xii + 754.

The new edition of *Psychology and life* differs from the first edition in several major respects. Considered generally, these changes are almost all in the direction of the traditional treatment of the subject matter of general psychology.

The most obvious change is the incorporation of two new chapters at the end of the book in a section called "Physiological Backgrounds." The two chapters of this section are entitled "The Form and Functioning of the Nervous System" (19 pages), and "Division of Labor in the Brain" (29 pages). This brief survey of the physiological and neurological correlates of behavior is clear and accurate and does not depend excessively upon analogies to clarify its meaning, though the perennial telephone switchboard makes its appearance and will doubtless appear incorrectly answered as an item in hundreds of true-false examinations. The criticism that may be appropriate to this section concerns the lack of integration with the preceding chapters. There is no doubt that the addition of

these chapters will make the book more popular, but it might be wished that along with the other changes in the book the subject matter of these last chapters had been made more relevant to the rest of the book. The author's aim of a "full-blown General Psychology" might better have been attempted by such a plan or by frankly setting it off as a mere appendix. The several pages on the "neurological basis of learning" cannot possibly give the critical student the assurance that the hypotheses are either bases for, or even clearly related to, the kind of learning and learning situations cited in previous chapters.

In one sense this criticism is only partly justified, for considerable revision has been made in the other sections of the book. Dr. Ruch seems to have successfully ignored the low interest value of students for such topics as mazes, animal learning, and the like, which was a guiding principle in the first edition. The book now contains numerous examples of animal experimentation and of experiments which are perhaps not of immediate major interest to students, but which have findings of significance for psychology. For example, in the first edition there was only one indexed reference to maze learning, whereas in the second edition four such references occur.

The new edition is a more objective and comprehensive textbook, and to the reviewer it is apparent that Dr. Ruch's happy faculty of getting the most out of his words is still retained. Sometimes a few words carry paragraphs of meaning, as, for example, the legend under an illustration of a fluctuating figure: "Much depends on how you look at things in life. Perception can shift—and shift—and perhaps lead to new solutions" (p. 269). The new edition is 75 pages longer than the old edition but has the same number of chapters (18). This has entailed some consolidation, and in addition there has been a change in the sequential order of presentation of topics. In the first edition personality, intelligence, applied psychology, etc. precede sections on the senses, perception, and learning, whereas in the revised edition the more logical and traditional sequence is used. This trend to conservatism is also noted in the appearance of the book. The full-page, marginless illustrations are missing in favor of the usual type of illustrations, and the chapter headings and subtitles are less attention-getting and more explanatory. One has the feeling that, given another revision, the section on physiological backgrounds would migrate to the front of the book and the metamorphosis into the traditional general psychology would complete itself. The revised edition is in many respects a better textbook, and some instructors who were antagonized by the excessive catering to student interest in the first edition, or who desire a somewhat more factual and conservative textbook, will do well to examine this new edition.

JACK BUEL.

Wesleyan University.

BRENNAN, R. E. Thomistic psychology: a philosophic analysis of the nature of man. New York: Macmillan, 1941. Pp. xxvi+401.

Dr. Brennan, an adherent of Thomistic philosophy, has written an excellent, straightforward account of the psychological system of Thomas

Aquinas. It is, of course, primarily a "philosophical" psychology. As one reads, it appears that the underlying motif of the book is to exhibit Thomism as fundamentally Aristotelianism. So undeviatingly is this point of view followed that the eleven chapters describing Aquinas' psychology proper take up *seriatim*, for more expanded discussion, the ordered topics of the author's concise exposition of Aristotle's own psychology, to which the brief opening chapter is separately devoted. But this is Aristotle as seen through Aquinas' glasses:

> . . . the perspective is derived . . . *from the perspective which Aquinas himself reveals in his commentaries on these texts* (author's italics).

Further:

> Perhaps the meaning . . . is not always the import that Aristotle himself had in mind. This is really beside the point since . . . the criterion . . . is not the authority of the Stagirite, but the truth of the matter. . . . The psychology of the Stagirite is perennial precisely for the reason that it is true; and the psychology of Aquinas is likewise enduring because, having fixed upon the truth of Aristotle's insights into human nature, it has preserved and ordered and systematically expanded upon these insights.

The perennial truth of the resultant Thomistic doctrine makes it an adequate frame within which any worthy findings of past, present, or future psychology take their ordered places. This adequacy is specifically emphasized in the final chapter of the book, "Modern Psychology and the Thomistic Synthesis," in which the author shows knowledge of latter day theoretical tendencies, with a partly sympathetic and a partly askance attitude toward their importance or their logic. The following quotations, for brevity's sake taken out of the fuller and supporting context, serve to symbolize the essence of the author's attitude.

> . . . I believe it can be shown that the philosophic outlook of the Angelic Doctor has a real bearing on the problems investigated by the experimenter and the clinician. This bearing or relationship is established at two points in the programs of scientific psychology: first, at the beginning, where the philosophic approach furnishes certain directive principles as to how investigative work shall be prosecuted; second, at the end, where the same outlook supplies further criteria as to how the results of investigation shall be interpreted.
>
> To illustrate: it should be clear to the scientist *preinvestigatively* that man is an essential composition of soul and body . . . . Similarly, it should be obvious to the scientist *postinvestigatively* that human thinking and human willing are irreducible to purely sensitive acts.

A few pages farther on:

> Finally, let us urge once more the point that not every philosophy is useful to the science of psychology, but only that analysis which expounds the truth of human nature. Such, I take it, is the analysis which was formulated over two thousand years ago by Aristotle, which was subsequently taken over, refined, and developed by Aquinas, and which presently is known as the traditional psychology.

As to the author's exposition as a whole, the reviewer feels, on the negative side, that it fails to bring out any essential contributions of Aquinas as distinguished from those of Aristotle. He gets from the text little impression of advance—after nearly sixteen centuries. Aquinas' own philosophical greatness is not evident to him. Aquinas appears chiefly as a devoted and significant editor and commentator—illustrating, expanding, illuminating, systematizing the master's thought—but not as an original thinker in his own right. Any student of the history of psychology would naturally look for explicit emphasis on Aquinas' differential contributions.

The author chose, rather, to present objectively the developed Thomistic doctrine. That he has done—clearly, systematically, in simple, readable, and untechnical language. Any who are interested in that significant phase of the historical development of psychological thinking could scarcely do better than to read Dr. Brennan's book.

ROSWELL P. ANGIER.

Los Ranchos Perkins,
Tucson, Arizona.

BOOKS AND MATERIALS RECEIVED

FREEMAN, W., & WATTS, J. W. Psychosurgery: intelligence, emotion and social behavior following prefrontal lobotomy for mental disorders. (With special psychometric and personality profile studies by T. Hunt.) Springfield, Ill.: Thomas, 1942. Pp. xii+337.

GLASER, E. M. An experiment in the development of critical thinking. *Teach. Coll. Contr. Educ.*, No. 843. New York: Bureau of Publications, Teachers College, Columbia Univ., 1941. Pp. ix+212.

GRAEBER, I., BRITT, S. H., *et al.* Jews in a gentile world: the problem of anti-Semitism. New York: Macmillan, 1942. Pp. x+436.

KINHART, H. A. The effect of supervision on high school English. *Johns Hopk. Univ. Stud. Educ.*, No. 30. Baltimore: Johns Hopkins Press, 1941. Pp. ix+102.

MCNEMAR, Q., & MERRILL, M. A. (Eds.) Studies in personality, contributed in honor of Lewis M. Terman. New York: McGraw-Hill, 1942. Pp. x+333.

SORENSON, H., & LEMON, A. C. Workbook for psychology in education. New York: McGraw-Hill, 1942. Pp. viii+178.

STOGDILL, R. M. Manual of directions for the behavior cards: a test-interview for delinquent children. Columbus: Hedrick (Psychological Corporation, Distr.), 1941. Pp. 18.

NOTES AND NEWS

DR. KURT KOFFKA, William Allen Neilson professor of experimental psychology at Smith College, formerly professor of psychology at the University of Giessen, died on November 23, 1941, at the age of 55.

DR. HARRY CAPPS, assistant professor of psychology at Louisiana State University, died on January 17.

DR. WAYNE DENNIS has been appointed professor of psychology and chairman of the department of psychology at Louisiana State University, Baton Rouge, Louisiana. The appointment became effective January 27.

DR. JOHN E. ANDERSON, director of the child welfare institute, University of Minnesota, has been appointed chairman of the Minnesota committee of the White House Conference on Children in a Democracy.—*Science.*

THE MIDWESTERN PSYCHOLOGICAL ASSOCIATION will hold its seventeenth annual meeting at Hotel Statler, St. Louis, Missouri, on Friday and Saturday, May 1 and 2, 1942, under the presidency of Dr. J. P. Porter. The title of his presidential address will be "Psychology and the Functional Integration of Human Behavior." The members of the department of psychology at WASHINGTON UNIVERSITY will act as hosts, with Dr. J. P. Nafe as Chairman of the local committee. On account of the considerable distance of the University from housing facilities, all meetings will be held at the Association headquarters, Hotel Statler, where special arrangements are being made.

THE NATIONAL INSTITUTE OF PSYCHOLOGY, at a meeting at Northwestern University, Evanston, Illinois, on September 4, elected the following officers: President—Dr. John A. McGeoch, the State University of Iowa; Vice-President—Dr. Ernest R. Hilgard, Stanford University; Secretary-Treasurer—Dr. G. R. Wendt, Wesleyan University; Directors—Dr. Walter R. Miles, Yale University, and Dr. L. L. Thurstone, University of Chicago.

A CONFERENCE OF PSYCHOLOGISTS ON THE DEVELOPMENT OF MORALE IN CHILDHOOD AND YOUTH was held at CLARK UNIVERSITY on November 28. The speakers included: Dr. Gordon Allport, Harvard University; Dr. Carroll Pratt, Rutgers University; Dr. Gregory Bateson, formerly of Cambridge University, England; Dr. Ronald Lippitt, Boy Scouts of America; and Dr. Karl Buehler, Dr. Charlotte Buehler, and Dr. Saul Rosenzweig, Clark University.

The final session of the Conference was devoted to a Round Table, led by President Leonard Carmichael, of Tufts College. About 200 attended.

The Chairman of the Conference was Dr. Vernon Jones, of Clark University.

A shortage of military psychologists in GERMANY has previously become known (*Psychol. Bull.*, 1941, **38**, 779). We are learning now of the

introduction of a new academic degree, DIPLOMA PSYCHOLOGIST, which appears as a means to cope with this shortage. The new degree ranks lower than the Ph.D., which up to this time has been the only academic degree conferred in psychology, as in most academic fields in Germany. The new title has a precedent in the old established title of Diploma Engineer.

The information is from *Psicotecnia*, 1941, **2**, 218, where we find under the heading "The title of 'Diploma Psychologist' in Germany" the following item:

> Need of the state, the army, and business with regard to psychology have demanded in Germany a broader basis for the training of professional psychologists. By decree of the Reich Minister of Education a regulation for the degree of Diploma Psychologist was put in effect beginning with April 1, 1941. The study of psychology may be pursued at all universities and institutes of technology where the specialty of psychology is represented by a chair of psychology and other chairs of related fields. The study of psychology takes a minimum of 6 semesters and terminates with the conferring of the academic title of *Diplom-Psychologe* (abbreviated *Dipl.-Psych.*). The examination for the diploma covers the following fields: diagnostic psychology, applied psychology, educational psychology, cultural psychology, psychology of other countries, and medico-biological auxiliary sciences as well as philosophy and world view (*Weltanschauung*).

A COMMEMORATIVE VOLUME prepared by a group of former graduates of the Stanford University psychology department was presented to PROFESSOR LEWIS MADISON TERMAN, chairman of that department since 1922, at a recent dinner given by Judge and Mrs. William F. James in honor of his birthday.

The volume, *Studies in personality, contributed in honor of Lewis M. Terman*, contains 16 original research papers prepared by psychologists who in the past have worked under Dr. Terman's direction at Stanford. All in the general field of personality, the papers range from studies of personality development and measurement to studies of psychical belief and abnormal phenomena. The volume includes an introduction by Robert S. Woodworth, emeritus professor of psychology at Columbia University, and a bibliography of Professor Terman's writings.

Editors of the volume were Dr. Maud Merrill James and Dr. Quinn McNemar, members of the Stanford psychology faculty.

THERE remain in the reserves of the Stanford University Library 11 copies of the MONOGRAPH of the late PROFESSOR JOHN E. COOVER on "Formal discipline from the standpoint of experimental psychology" (*Psychol. Monogr.*, 1916, **20**, No. 3, pp. 307). Anyone wishing a copy of this monograph for his college or university may obtain it gratis by having the librarian of his college or university request it from The Librarian, Stanford University, California. First come, first served.

AT a meeting of the Western members of the BIOMETRIC SECTION OF THE AMERICAN STATISTICAL ASSOCIATION held on the Berkeley campus of the University of California from December 29 to 31, 1941, a resolution to establish a permanent organization to be known as the WESTERN SO-

CIETY OF BIOMETRICIANS was passed. An Organizing Committee, including representatives from all directions of research that would be interested in the new Society, was elected. A proposal, originating earlier with the Biometric Section of the American Statistical Association, to establish a new journal for the publication of biological papers using mathematics in amounts too burdensome for purely biological journals was also warmly endorsed.

The officers and members of the elected Organizing Committee are as follows: Chairman—Dr. J. Neyman (Mathematical Statistics), University of California, Berkeley; Vice-Chairmen—Dr. E. B. Babcock (Genetics), Dr. R. T. Birge (Physics), Dr. E. C. Tolman (Psychology), all from the University of California, Berkeley; Secretaries—Dr. E. Dempster (Genetical Effects of Irradiation), University of California, Berkeley; Mr. G. Hormay (Range Management), California Forest and Range Experiment Station, Berkeley; Members—Dr. H. Borsook (Biochemistry), California Institute of Technology, Pasadena; Dr. F. N. Briggs (Plant Breeding), University of California, Davis; Professor A. G. Clark (Mathematical Statistics), Colorado State College, Fort Collins; Dr. S. Emerson (Genetics and Population Studies), California Institute of Technology, Pasadena; Dr. H. O. Halvorson (Bacteriology), University of Minnesota, Minneapolis; Mr. A. A. Hasel (Silviculture), California Forest and Range Experiment Station, Berkeley; Dr. P. C. Hoel (Mathematical Statistics), University of California, Los Angeles; Dr. J. A. Jenkins (Cytogenetics), University of California, Berkeley; Dr. G. F. MacLeod (Entomology), University of California, Berkeley; Dr. A. G. Marshak (Biophysics), University of California, Berkeley; Dr. J. R. Oppenheimer (Theoretical Physics), University of California, Berkeley.

All persons interested in the new society are invited to communicate with one or another member of the Organizing Committee.

THE NEUROLOGY OF SPEECH AND READING, a course dealing with causes and treatment of language problems, will be given by Dr. Edwin M. Cole and his associates at the Massachusetts General Hospital, Boston, during the month of July, 1942. The course consists of 20 morning lectures and clinic demonstrations by physicians and educators, covering problems in speech and reading as seen by teachers in their daily work at school and by physicians in their practice. For further particulars, write to Miss Miriam Phelps, Language Clinic, Box 396, Massachusetts General Hospital, Boston, Massachusetts.

"Making the Findings of Research Useful" was considered by WILLARD OLSON, of the University of Michigan, in addressing the NATIONAL ASSOCIATION FOR NURSERY EDUCATION at its recent Detroit conference.

In pointing out that the application of research was a research process and therefore subject to its rules, Dr. Olson outlined three criteria in applying research: (1) The problem should be defined by people applying the findings; (2) solution of the problem should involve participation of the practitioner; (3) applied research should use something more than common sense—that is, should actually involve the collection of data and making of proper generalizations.

In summarizing conference trends, ALICE KELIHER, assistant professor of education at New York University, pointed out that actual real advances had been made in understanding human conduct, particularly in the realm of emotions.

CREATION OF THE OFFICE OF PSYCHOLOGICAL PERSONNEL

Psychologists will be interested in the following resolution adopted unanimously by the Council of the American Psychological Association in February, 1942:

WHEREAS the Nation finds itself in a grave emergency requiring the efficient utilization of available man power; WHEREAS psychologists in increasing numbers are bringing their special training to bear on the conduct of the war; WHEREAS the several services and various institutions are facing serious shortages or dislocations; WHEREAS Associates and Members of the American Psychological Association have indicated unequivocally by a poll and actions at the Annual Meeting their desire for extended services in their behalf; and WHEREAS a formal request for such extension has been received from the Emergency Committee in Psychology of the National Research Council;

BE IT RESOLVED: (1) that the Association take steps immediately to establish an Office of Psychological Personnel to be concerned with the maximum, effective use of psychologists, irrespective of society membership, in the war effort; (2) that the Council exercise its powers to extend the functions of the Secretary's office by the appointment of an Assistant Secretary to be known also as the Executive Director of the Office of Psychological Personnel; (3) that Council appropriate at once the sum of four thousand dollars ($4000) for the part-time salary of the Executive Director, secretarial assistance, and operating expenses for the period of February 1, 1942, to October 1, 1942; (4) that the continuation of the office, its relation to the Secretary's office, and its continued support be reviewed at the next Annual Meeting of the Association; (5) that the Chairman of the Division of Anthropology and Psychology be requested to make the necessary arrangements, if possible, for the location of the office in the headquarters of the National Research Council in Washington or to make other suitable arrangements that will obviate the payment of rent; (6) that foundation assistance in the support of the office be welcomed if obtainable; and (7) that the Treasurer be authorized to draw drafts on any available funds of the Association for the purposes specified above.

Signed,

Council of Directors

ELMER A. CULLER
HORACE B. ENGLISH
JOY B. GUILFORD
EDWIN R. GUTHRIE
EDNA HEIDBREDER
ERNEST R. HILGARD
CALVIN P. STONE, *President*
WILLARD L. VALENTINE, *Treasurer*
WILLARD C. OLSON, *Secretary*

Plans for the office were presented by the Emergency Committee in Psychology through its Chairman, Karl M. Dallenbach. Leonard Carmichael, Chairman of the Division of Anthropology and Psychology of the National Research Council, has completed arrangements for the necessary office space. Dr. Steuart Henderson Britt has been appointed Executive Director and should be addressed at the National Research Council, 2101 Constitution Avenue, Washington, D. C.